PB-217 886

WATER INFILTRATION CONTROL TO ACHIEVE MINE WATER POLLUTION CONTROL - A FEASIBILITY STUDY

Frank J. Zaval, et al

West Virginia Department of Natural Resources

Prepared for:

Environmental Protection Agency

January 1973

DISTRIBUTED BY:

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W73-06892

EPA-R2-73-142
JANUARY 1973

Environmental Protection Technology Series

PB 217 886

Water Infiltration Control to Achieve Mine Water Pollution Control

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U.S. Environmental Protection Agency
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SELECTED WATER RESOURCES ABSTRACTS

INPUT TRANSACTION FORM

1. Report No.

2.

3. Accession No. **W**

4. Title Water Infiltration Control to Achieve Mine Water Pollution Control - Feasibility Study.

5. Report Date

6.

7. Author(s) Zaval, Frank J. and Robins, John D.

8. Performing Organization Report No.

9. Organization ~~State o~~f West Virginia, Department of Natural Resources (Grantee)
Cyrus Wm. Rice Division - NUS Corporation (~~Consultant~~ ~~Contractor~~)

10. Project No. EPA Project 14010 HHG

11. Contract/Grant No.

12. Sponsoring Organization

13. Type of Report and Period Covered

15. Supplementary Notes

Environmental Protection Agency report ~~number~~, EPA-R2-73-142, January 1973. Technology Series

16. Abstract

The study objective was the determination of the feasibility of conducting a full-scale demonstration to document the effectiveness of land reclamation at mined-out areas, in establishing surface water infiltration control to prevent acid mine water pollution. The study site was the Dents Run Watershed, Monongalia County, West Virginia. It is replete with strip, drift, and auger mines, refuse dumps, and discharge boreholes; all of which are significant potential contributors of acid mine water pollution.

The project is feasible as based upon the results of investigative measures which included: investigation of each mine area and opening; a detailed description of each site; sampling and analysis of all receiving streams and discharge points to determine the severity of acid mine water pollution; and evaluation and selection of weir structures, monitor and enclosures and instruments to be placed in unattended areas to provide a continuous record of stream conditions.

~~A presentation is made of~~ recommendations and cost estimates for reclamation at each site and for the installation of monitoring facilities.

The impact of the project on the social and economic environment of the watershed and the county is presented.

This ~~report~~ was ~~submitted in fulfillment of Project No. 14010 HHG under~~ the sponso~~rship of the Office of Research & Monitoring~~, EPA.

17a. Descriptors

Acid Mine Drainage, ~~Surface Mines*~~, Underground ~~Mines*~~, *Land Reclamation*, revegetation, water quality, *[illegible]*

17b. Identifiers

*seals - mine entry, *reclamation - strip mine, ~~feasibility study, stations - stream monitoring, West Virginia~~

Surface mines

17c. COWRR Field & Group 05G

18. Availability

19. Security Class (Report)

20. Security Class (Page)

21. No. of Pages

22. Price

Send To:

WATER RESOURCES SCIENTIFIC INFORMATION CENTER
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D.C. 20240

Abstractor Robert A. Loos

Institution Cyrus Wm. Rice Division - NUS Corporation

EPA-R2-73-142
January 1973

WATER INFILTRATION CONTROL TO ACHIEVE MINE WATER POLLUTION CONTROL

A FEASIBILITY STUDY

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U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Price $2.35 domestic postpaid or $2 GPO Bookstore

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This report has been reviewed by the Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

The objective of this study was the determination of the feasibility of conducting a full-scale demonstration project showing the effectiveness of land reclamation measures, at mined-out areas, in establishing surface water infiltration control to prevent acid mine water pollution. The Dents Run Watershed, located in Monongalia County, West Virginia, was the site selected for the study. It is replete with strip mines, drift mines, auger mines, refuse dumps, spoil banks, and discharge boreholes; all of which are significant contributors of acid mine water pollution.

Project feasibility is based upon the performance and results of investigative measures which included: investigation of each mined area and abandoned drift openings, which resulted in a detailed description of each site; sampling and analysis of all receiving streams and discharge pits to determine the severity of acid mine water pollution; and evaluation and selection of weir structures, monitor enclosures and instruments to be placed in unattended areas to provide a continuous record of stream conditions. A presentation is made of recommendations for reclamation and treatment at each site; and pertinent cost estimates are developed for the construction, installation and operation of monitoring facilities as well as the reclamation work.

This report was submitted in partial fulfillment of Project No. 14010 MHG under the sponsorship of the Office of Research and Monitoring, Environmental Protection Agency, and West Virginia Department of Natural Resources by Cyrus Wm. Rice Division, NUS Corporation, Pittsburgh, Pennsylvania 15220.

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SECTION I

CONCLUSIONS

1. This study has shown that a demonstration of the use of water infiltration control methods to eliminate or control acid mine drainage in the Dents Run Watershed is feasible, and this location meets the requirements of Section 14 of the Federal Water Pollution Control Act.

2. The volume of acid mine drainage in the Dents Run Watershed can be significantly reduced by implementing surface reclamation techniques to reduce surface water entry into abandoned deep mines.

3. Observed preliminary flow data indicates that, during the normal low rainfall periods of the area, a major portion of the total flow in Dents Run is comprised of borehole discharges from the active mining operations of the Christopher Coal Division of the Consolidation Coal Company.

4. Christopher Coal's pumping rates are considerably influenced by regional rainfall, and a substantial portion of the discharge from active workings comes from the diversion of surface water into abandoned workings by the unreclaimed surface mines. Christopher Coal Company has notified the State of their intent to neutralize all the water presently being discharged into the watershed from their active boreholes.

5. The normal volumes of water discharged from abandoned workings in the watershed do not warrant the use of hydraulic seals. It is anticipated that effective surface reclamation techniques will reduce the volume of these drainages to insignificant levels.

6. An unaccountable loss in stream flow was observed in Dents Run in the vicinity of Laurel Point. It is believed that this water drains back into the Pittsburgh coal seam through fracture zones or fissures within the stream bed.

7. The effectiveness of the project in controlling surface water infiltration into the groundwater system can be measured directly by monitoring stream flows, Christopher Coal pumping rates and discharges from abandoned drift openings.

8. The cooperative effort of government and industry in the control, abatement and treatment of acid mine drainage will result in nearly 100% mine drainage control within the Dents Run Watershed.

9. The elimination of acid mine water pollution in the watershed will reflect a social and economic environmental impact by helping to fulfill the increasing water usage demand of the public and serve to encourage industrial investment in the area with the availability of a more reliable source of usable water.

SECTION II

RECOMMENDATIONS

1. The approval to proceed with the design engineering, construction and monitoring phases of this demonstration is recommended.

2. A network of seven stream monitoring stations should be installed at the selected points in the watershed in order to effectively document the control measures being demonstrated. These monitoring stations should provide a continuous record of flow, pH and conductivity.

3. Event recorders and weirs should be installed at each of the borehole discharges to continuously monitor the quantity of the discharge at each location. Monthly water samples should be collected at each of the six boreholes and analyzed for alkalinity, total acidity, conductivity, pH, turbidity, calcium, magnesium, sulfate, total iron, ferrous iron, total solids, suspended solids, dissolved solids, settleable solids, aluminum and manganese. This will provide the data required for making a quantitative and qualitative estimate of the effectiveness of the surface reclamation in reducing infiltration into the deep mine workings.

4. Surface reclamation techniques should be employed to backfill the unreclaimed strip mines with emphasis placed on those areas which channel surface water runoff into intercepted deep mine workings. The priority classifications should be as follows:

   Priority I - Areas showing evidence of water infiltration.

   Priority II - Areas contributing to stream pollution as a result of contaminated surface water runoff.

   Priority III - Areas contributing to aesthetic pollution.

The reclamation technique to be used at each site will be dependent upon the conditions of that specific area.

5. Stream flows in the Laurel Point area of Dents Run should be further investigated in order to pinpoint a specific zone in which the apparent water loss may occur. If a specific area is located, stream channelization should be employed to prevent future infiltration of this water into the subsurface water system.

6. Weekly water samples should be collected and flows measured at each of the nine stream monitor stations. These samples should be analyzed for alkalinity, total acidity, conductivity, pH, turbidity, sulfates and total iron.

   This sampling program should be continued until a definite correlation can be developed between these parameters and the data recorded by the monitoring equipment. In addition, samples should be collected at sample points 1 through 10 once each month and analyzed for all other parameters as listed in paragraph 3.

7. In order to achieve a public awareness of the social and economic impact of the project, it is recommended that as portions of the watershed become pollution free this information should be released to State and Municipal agencies and the public via press releases. This should stimulate public interest as well as the interest of industrial, residential and recreational developers.

SECTION III

INTRODUCTION

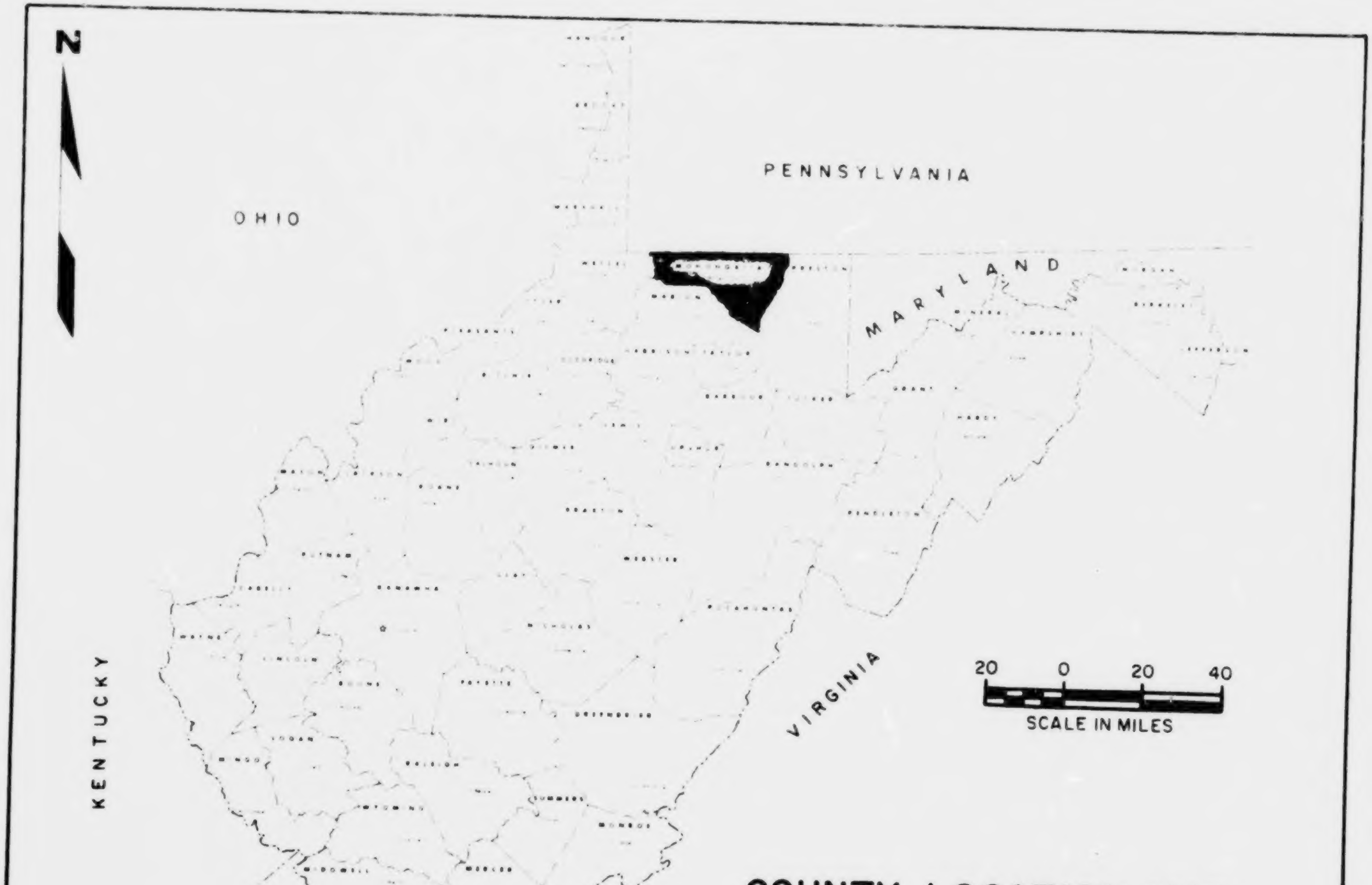
West Virginia is one of the leading coal producing states in the nation; as a result of such activity, acid mine drainage is and has been a significant problem in the surface streams of the State. Acid mine drainage has gone unchecked for years and only until recently have regulations and powers of enforcement been established to control the deleterious effects of such pollution.

Present regulations and authority have sufficient power to cause active operators to restore their workings at the conclusion of operations, as well as control their discharges during the period of active mining. However, because of the extensive number of abandoned sites in the Dents Run Watershed, it is necessary for the State to take the necessary action required to control or eliminate the acid mine drainage from these sites. This requires the implementation of proper procedures and techniques for regrading the sites, covering refuse material, installing compaction seals, conditioning the soil and planting various species of grasses and trees.

The feasibility study presented herein is a thorough analysis of the Dents Run Watershed as the site of a demonstration project to control mine water pollution by water infiltration control.

This study has been conducted consistent with the total demonstration program of the U. S. Environmental Protection Agency. The program was established to fulfill the provisions of the Water Quality Improvement Act of 1970, PL 91-224, which included a subsection titled "Area Acid and Other Mine Water Pollution Control Demonstrations" which became Section 14 of the Federal Water Pollution Control Act, as amended.

The Dents Run Watershed is located in Monongalia County, West Virginia, and is a part of the Monongahela River Basin (see Figure 1). The watershed has an area of 14.6 square miles with the main axis being in a generally east-west direction. The watershed is drained by Dents Run



N
OHIO
PENNSYLVANIA
MARYLAND
KENTUCKY
VIRGINIA
20 0 20 40
SCALE IN MILES

COUNTY LOCATION MAP

FIGURE 1

and small tributary streams which flow from west to east. The discharge of Dents Run is into the Monongahela River at the City of Granville, which is due west of the City of Morgantown.

The terrain of the eastern part of the watershed can generally be described as rugged where valleys are deep and narrow; the western portion of the watershed has a more subdued topography and can generally be described as rolling. The relief over the entire area is approximately 800 feet, with the base line elevation being 830 feet at the mouth of Dents Run. The watershed is part of the Appalachian Plateau's physiographic province and is located in the Allegheny Mountains section.

The Dents Run Watershed is underlain principally by sedimentary rocks of the Pennsylvanian Age. The principal coal mining and oil and gas development in this area has been in the Monongahela Group of this system. The Monongahela Group is comprised of the youngest rocks of Pennsylvanian Age and is typically composed of cyclic sequences of sandstone, siltstone, red and gray shale, limestone and economically important coal beds. The most prominent and commercially developed beds in the watershed area are the Pittsburgh, the Redstone, the Sewickley and the Waynesburg.

There are presently two active deep mining operations in the Dents Run Watershed; both mines, namely the Osage and the Arkwright, are owned and operated by the Christopher Coal Division of the Consolidation Coal Company and are located in the Pittsburgh coal seam. Extensive mining of the Pittsburgh coal seam has lowered the water table in this area to the base of the coal seam. In order to maintain active mining operations within the watershed, Christopher Coal removes accumulated groundwater through a system of six boreholes at the average rate of approximately 3.0 million gallons per day. Pumping rates are influenced by the seasonal fluctuation and magnitude of the regional precipitation.

Most of the unreclaimed surface disturbance has occurred in the eastern portion of the watershed. Water that enters the subsurface water system as a result of numerous drift mine interceptions located in the unreclaimed areas eventually drains into the Pittsburgh seam. Surface reclamation techniques that would backfill the surface mine pits, cover the exposed seam and seal the exposed drift mine entries or interceptions would reduce the surface water entry into the subsurface water system. The intercepted runoff would be channeled to the normal surface drainage courses in the watershed.

The watershed is sparsely populated with small individual homes scattered throughout the watershed along Dents Run. They represent a population of possibly several hundred total, except for the Town of Granville and the Morgan Heights section of the Town of Westover which have a combined population of approximately 1,500.

Neither the City of Granville nor the Morgan Heights section of Westover are sewered. Both communities rely on septic tanks with the homes located adjacent to either Dents Run or the Monongahela River discharging wastes directly into the stream or the river. The City of Westover is considering installation of a sewer system and piping the sewage under the Monongahela River to connect into the sewer system and treatment plant of the City of Morgantown. The City of Granville has no plans of its own for handling its sewage. The Water Resources Division preliminary plans are for Granville and Westover to join together and convey the joint sewage under the river to Morgantown, or to jointly build a treatment system on the west side of the Monongahela River. Neither community has received orders to install sewage treatment facilities; however, all communities in the State of West Virginia are required to have at least secondary treatment by 1975.

While the object of the demonstration project itself will be the control of water infiltration, the project is part of an overall watershed plan that involves the cooperation of government, industry and municipalities.

It is anticipated that successful reclamation of those areas which are now diverting surface water runoff into abandoned drift mines could reduce infiltration into the active drift mine workings by as much as 50 percent. Consolidation Coal Company is in the process of installing treatment facilities to treat the discharge from the boreholes to comply with West Virginia discharge regulations.

SECTION IV

JURISDICTIONAL FRAMEWORK

Cognizant Authority

This study has been conducted under the auspices of the Environmental Protection Agency. The Agency is subject to the provisions of the Water Quality Improvement Act of 1970, PL 91-224. The Act includes a subsection titled "Area Acid and Other Mine Water Pollution Control Demonstrations" which became Section 14 of the Federal Water Pollution Control Act, as amended. This section provides for the demonstration of techniques for mine drainage pollution control and directs that the Environmental Protection Agency shall require such feasibility studies as necessary in selecting watersheds for the purpose of the demonstration projects. Such feasibility studies are to aid the Environmental Protection Agency in selecting not only the mine drainage pollution control method(s), but also the watershed or drainage area for such application. The Act requires that the Environmental Protection Agency give preference to areas which will have the greatest public value and uses.

The Environmental Protection Agency, Office of Research and Monitoring, issued a Grant for the mine drainage demonstration project, described herein, to the State of West Virginia, Department of Natural Resources. Administration of the study has been the responsibility of the State of West Virginia's Department of Natural Resources.

The Department of Natural Resources is a statutory unit of the West Virginia government headed by a Director. The Department has the authority to exercise all state administrative functions relating to surface mining and the reclamation of surface mined lands in West Virginia. Such administration is performed through the Department's Division of Water Resources and the Division of Reclamation.

Each division also has subordinate governing bodies established under the law within its operating structure.

The Water Resources Board is an appeal board of the Division of Water Resources and the Reclamation Commission is a part of the Division of Reclamation. The authority of the Reclamation Commission is covered by Chapter 20, Article 6, Section 6 of the 1967 Surface Mining Act, which is presented in its entirety in the Appendices.

The Department of Natural Resources is charged with the responsibility of administering and enforcing the 1967 Surface Mining Act enacted by the Legislature of West Virginia on March 9, 1967. The rules and regulations established pertain to the reclamation of areas disturbed by surface mining operations, particularly with regard to requirements for permits, performance bonds, haulage-ways, backfilling and regrading, revegetation, sealing and treatment of acid water breakthrough, prospecting, and other mining operations on disturbed areas.

The 1967 Surface Mining Act created, within the Department of Natural Resources, a Division of Reclamation whose Chief is responsible for admininstration of all of the laws of the State of West Virginia relating to surface mining. The Department has jurisdiction and control over land, water and soil aspects pertaining to surface mining operations, and the restoration and reclamation of surface mined lands and related affected areas. The authority of the Division is covered in Section 20-6-3 of the 1967 Surface Mining Act, which appears in its entirety in the Appendices.

The Director of the Department of Natural Resources also has the overall supervision of the Water Pollution Control Act of the State of West Virginia (Article 5A, Chapter 20 of the Code of West Virginia, 1969, as amended). Authority for the general administration and enforcement of the Act has been vested in the Division of Water Resources. The Division has within its jurisdiction and supervision, the administration and enforcement of all laws relating to water pollution control.

Authority is vested in the Division of Water Resources under the Water Pollution Control Act to cooperate with other governments and agencies as provided in Section 20-5A-4 of Article 5A, Chapter 20 of the Code of West Virginia, 1969, which is presented in its entirety in the Appendices.

The Division of Water Resources is primarily involved in the administration of regulations for the control and reduction of pollution in the waters of the State. Their authority is directed to direct and indirect discharge, deposition or disposal of all treated or untreated sewage, industrial wastes, other wastes or the effluent therefrom, into the waters of the State or any underground strata. The Board's primary concern is the establishment of standards of quality for the protection of the public health and welfare, wildlife, fish and aquatic life and all present and prospective future uses of the State's waters primarily for domestic, agricultural, industrial and recreational purposes. With regard to the foregoing, the agency regulates mine drainage discharges by monitoring compliance with the established water quality criteria and controlling discharges by the issuance or revocation of permits.

Although both Divisions aforementioned shall have jurisdiction in the project, involvement of the Division of Water Resources will be contingent upon the proper performance of reclamation work under the regulations administered by the Division of Reclamation.

Reclamation work in the watershed will be performed in accordance with applicable regulations (see the Appendices for pertinent portions of the laws).

Detailed water quality standards and reclamation procedures are now in existence. The project will be conducted in compliance with all regulations resulting in the restoration of the land more nearly to the natural contours of the area.

Full responsibility for the contractual agreement, administration and operation of the demonstration project rests with the Department of Natural Resources of the State of West Virginia; however, the Department may see fit to delegate the performance of some tasks to competent contractors. Therefore, the present legal and administrative structure is adequate for conducting the project since all authority for water pollution control and reclamation of surface mined lands is now vested in the Department and its Divisions. This is covered by the foregoing jurisdictional authority and the pertinent sections of the law included in the Appendices.

Existing and Proposed Standards

The site of the demonstration project is within the jurisdiction of the State of West Virginia. The streams involved are considered public streams of the State and are thereby subject to the most stringent of all applicable water quality standards imposed by the Federal Government and the State of West Virginia.

Present standards relative to wastewater discharges, including acid mine drainage to the Dents Run Watershed, are subject to enforcement by the Division of Water Resources of the State of West Virginia. The general standards indicate the quality criteria for such waters, and are delineated in detail in Section 3 and 5 of the West Virginia Administrative Regulations presented in its entirety in the Appendices.

Dents Run, a tributary of the Monongahela River, is subject to the specific water use and water quality criteria applicable to the Monongahela River, which are delineated in Sections 6 and 13 of Series II of the State's administrative regulations presented in the Appendices.

At the present time, the water quality standard for sulfates (see 13.01 h. 9. of the regulations as presented in the Appendices) is not considered binding due to the current level of technology in sulfate removal and the cost effectiveness of such removal.

The purpose of the project is not designed to bring the streams into total compliance. The project as now envisioned will only monitor the effectiveness of the infiltration control methods applied with respect to a change in stream acidity from the highly acid conditions now present to the minimum allowable pH level of 5.5 stipulated in the established water quality criteria. However, bringing pH into compliance with the existing standards will prove to be of significant value since the watershed area is to be capable of meeting the water uses specified (recreation, public water supply and industrial water supply). The most noticeable influence a change in pH could make would be its effect in making stream waters acceptable for swimming and establishing a favorable condition for the development of such (recreational use), and reduction of treatment requirements to make the waters acceptable for public consumption (public water supply use).

Stream compliance with other water quality criteria can be accomplished through additional treatment methods, which of necessity become a part of future projects. The full impact of the effect of infiltration control methods applied in this project will not be fully appreciated until the watershed system reaches a new equilibrium, vegetative growth is established and groundwater flow is stabilized. In accordance with the provisions of the West Virginia Administrative Regulations, enforcement of said regulations and related water quality standards is entrusted to the State Water Resources Board and the Chief of the Division of Water Resources. He has the power and authority to determine who is responsible for polluting the State's waters and to prevent, control, eliminate or reduce such pollution. Consideration is given to those that use available and reasonably practicable methods to control and/or reduce pollution. Therefore, since the Division serves as the State's regulatory agencies, it has the authority, knowledge, regulations, etc., available to monitor implementation of the project plans in accordance with applicable standards.

Site Acquisition

The site of the demonstration project is located within the boundaries of the State of West Virginia. Authority is vested in the Chief of the Division of Water Resources to acquire land, as required, through the power of eminent domain as detailed by Section 20-5A-11a of Article 5A, Chapter 20 of the Code of West Virginia, 1969, which is presented in its entirety in the Appendices.

The demonstration project site encompasses the entire Dents Run Watershed, an area of 14.6 square miles. Due to its extensive proportions, the land is believed to be held in private ownership by numerous individuals and several coal companies. The property owners for each of the stream monitor stations and borehole locations have been identified. Each of the stream monitor station property owners were contacted and a verbal agreement was made for the installation of the monitor stations and associated structures. The State of West Virginia is presently in the process of obtaining a formal release from the owners involved. At this time, the survey has not been completed to determine the precise ownership of the affected land within the watershed. However, reclamation work required to establish infiltration control in the watershed will eventually require contact with all affected land owners. It is not anticipated that transfer or acquisition of the property will be required, but that a release may be obtained from the owners involved to conduct the required project tasks on their property. The owners of the property are under no obligation to participate in such a project, except as the Division of Water Resources may have jurisdiction over the maintenance of the safety, health and welfare of the citizens of the State. Successful acquisition of releases to perform the project tasks will preclude the necessity of invoking the power of eminent domain.

Authority for Funding

Federal funding for this project was provided by a Grant to the State by the Environmental Protection Agency under authority of Section 14 of the Federal Water Pollution Control Act, as amended. The grant offer was made to the State of West Virginia's Department of Natural Resources. The 1967 Surface Mining Act, a revision to the Code of West Virginia, provides that the Director of the Department of Natural Resources may receive any Federal funds, State funds, or any other funds for the reclamation of land affected by surface mining.

A source of funding for the Department, a provision of the 1967 Surface Mining Act, is the requirement that every applicant for a permit to surface mine coal shall pay to the Department of Natural Resources a special reclamation fee for each acre of land to be affected in the mining operation. The fees obtained are to be deposited in a special reclamation fund to be administered by the Director of the Department of Natural Resources. The Director shall use the special reclamation fund for reclamation and rehabilitation of lands which are unreclaimed. The Director may also use some of the special reclamation fees collected for the purchase of orphaned surface mined lands, for the reclamation thereof, and for the engineering, administrative and research costs necessary, providing that Federal funds on a matching basis are made available for the purpose of reclaiming said orphaned surface mined lands. Under the Act, any funds legally available to the Director of the Department of Natural Resources may be expended and used to reclaim and rehabilitate any lands that have been subjected to surface mining that have not been reclaimed and rehabilitated in accordance with standards set by the Director and which are not covered by bond to guarantee such reclamation.

Whenever acid mine drainage control measures are an integral part of a reclamation project, the Chief of the Division of Reclamation can execute agreements with the Chief of the Division of Water Resources for the supervision of specific reclamation projects, utilizing fees from the special reclamation fund. Such agreements can only be consummated by direct administrative actions within the Department of Natural Resources.

The Chief of the Division of Water Resources, the water pollution control agency of the State of West Virginia, may cooperate with all persons, agencies of the State, federal or other state agencies, and interstate agencies for the control and reduction of pollution in the waters of the State. Authority for such cooperation is set forth in the Water Pollution Control Act, Chapter 20, Article 5 of the West Virginia Code as amended in 1969. It also provides that the Department of Natural Resources may apply for and accept, on behalf of the State, all monies for such endeavors of cooperation between the Division and the aforementioned agencies, officers and persons. Money so acquired is placed in a special fund administered solely by the Chief of the Division for the purposes delineated by the grant, gift or contribution. The fund also contains the fees collected for wastewater discharge permits, some of which originate from intentions to open, reopen, operate or abandon a mine, quarry or preparation plant or to dispose of any refuse or industrial wastes from same.

Water and Mineral Rights

Property ownership and the associated title to the water and/or mineral rights in the Dents Run Watershed area, designated site of the demonstration project, are of major concern with respect to project progress. Releases will be required from all owners of property upon which reclamation work will be performed, because it will involve sealing of drift mines, burial of refuse material, regrading of spoil banks, lowering of highwalls, and revegetation of areas worked. Since the project is being conducted under the direction of the regulatory bodies of the State, it is anticipated that there will be no problem in obtaining releases and cooperation for such work, because it relieves owners and operators from such responsibility under the law.

Surface water flowing through a property is generally considered as public water of the State of West Virginia. Ownership of this resource is, therefore, not a question since the project is being implemented by an agency of the State, who holds public ownership of same.

The Dents Run demonstration site is underlain with four major coal seams: the Pittsburgh, the Redstone, the Sewickley and the Waynesburg. The only seam actively mined to any degree is the Pittsburgh, the mineral rights to which are generally considered to be owned by the Christopher Coal Company.

No purchase or transfer of rights or ownership is expected for any portion of the project, since active mining operations will not be disturbed. The majority of the individual sites within the project area represent abandoned drift or strip mines.

Prevention of Future Pollution

The 1967 Surface Mining Act and the Water Pollution Control Act of the State of West Virginia, administered by the Department of Natural Resources, provide the regulations necessary for land reclamation and rehabilitation with requisite mine drainage control measures, as well as the control and reduction of pollution in the State's waters.

The Water Pollution Control Act of the State of West Virginia (Article 5A, Chapter 20 of the Code of West Virginia, 1969, as amended) provides for pollution control and continuing jurisdiction over same as indicated by Section 20-5A-2, 20-5A-3 and 20-5A-14 of the article, which are presented in their entirety in the Appendices.

The Water Resources Division has clear jurisdiction over control measures applicable to acid mine drainage, as defined within the Water Pollution Control Act. Therefore, at present and in the future, all State waters shall be subject to the control measures as given in Section 5, Series I, Chapter 20-5 and 20-5A of the West Virginia Administrative Regulations which is presented in its entirety in the Appendices.

The 1967 Surface Mining Act provides specifically for the prevention of future pollution at any and all sites in the State because of its provisions governing reclamation procedures and administration. Specific regulations covering reclamation procedures and revegetation techniques and standards were established in Article 6, Chapter 20, of the Code of West Virginia in 1967, which are to be administered under the provisions of the aforementioned Act. Administration of the foregoing rests with the Director of Natural Resources, the Division of Reclamation and the Reclamation Commission, each of which has specific areas of responsibility with respect to the law, which are defined in detail in the Act.

The water infiltration control procedures outlined for implementation as a part of this project are in keeping with the laws and regulations established, and are applicable to any future work which might be required to overcome deleterious drainage effects upon the Dents Run Watershed from adjacent property and workings. Such property and workings are also subject to the regulations now on the books and would be required to comply with same; otherwise they would risk the loss of permits granted, performance bonds posted and all fees paid.

The State of West Virginia assures the Environmental Protection Agency that it will exercise its authority under State statutes to provide legal and practical protection to the project area to insure against any activities which will cause future acid or other water pollution.

SECTION V

INVENTORY AND FORECAST

Physical Conditions

The Dents Run Watershed lies entirely within Monongalia County, West Virginia. The watershed is described on the U. S. Geological Survey 7.5 minute topographic quadrangle maps - (1) Osage, West Virginia, (2) Rivesville, West Virginia, (3) Morgantown North, West Virginia, and (4) Morgantown South, West Virginia (see Figure 2). The watershed is traversed along its southern boundary by U. S. Route 19, which follows the course of Dents Run from a point opposite Morgan Heights westerly to Laurel Point. Interstate Highway 79 is presently under construction crossing Dents Run at the eastern end in a north-south direction.

The elevation of the highest peak in the watershed is approximately 1,600 feet, while the valley floor in the vicinity of Laurel Point is 956 feet with a base of 830 feet at the mouth of Dents Run. The mountain tops are forested, while the valley sides and bottom are open grassland and farmland.

Aerial photographs were taken of the area during September of 1971. A photographic mosaic of the area is illustrated in Figure 3.

The valley is underlain with four coal seams that outcrop along the valley sides beginning at the mouth of Dents Run near Granville. The lowest of these is the Pittsburgh seam. The Redstone seam is approximately 30 feet above the Pittsburgh seam; the Sewickley seam is approximately 90 feet above the Pittsburgh seam; and the Waynesburg seam is approximately 350 to 375 feet above the Pittsburgh seam. The Pittsburgh seam and all others above it dip to the west. The elevation of the Pittsburgh seam is approximately 1,000 feet at Granville and about 750 feet in the western section of the watershed near Sugar Grove. The valley floor elevation at Sugar Grove is approximately 1,100

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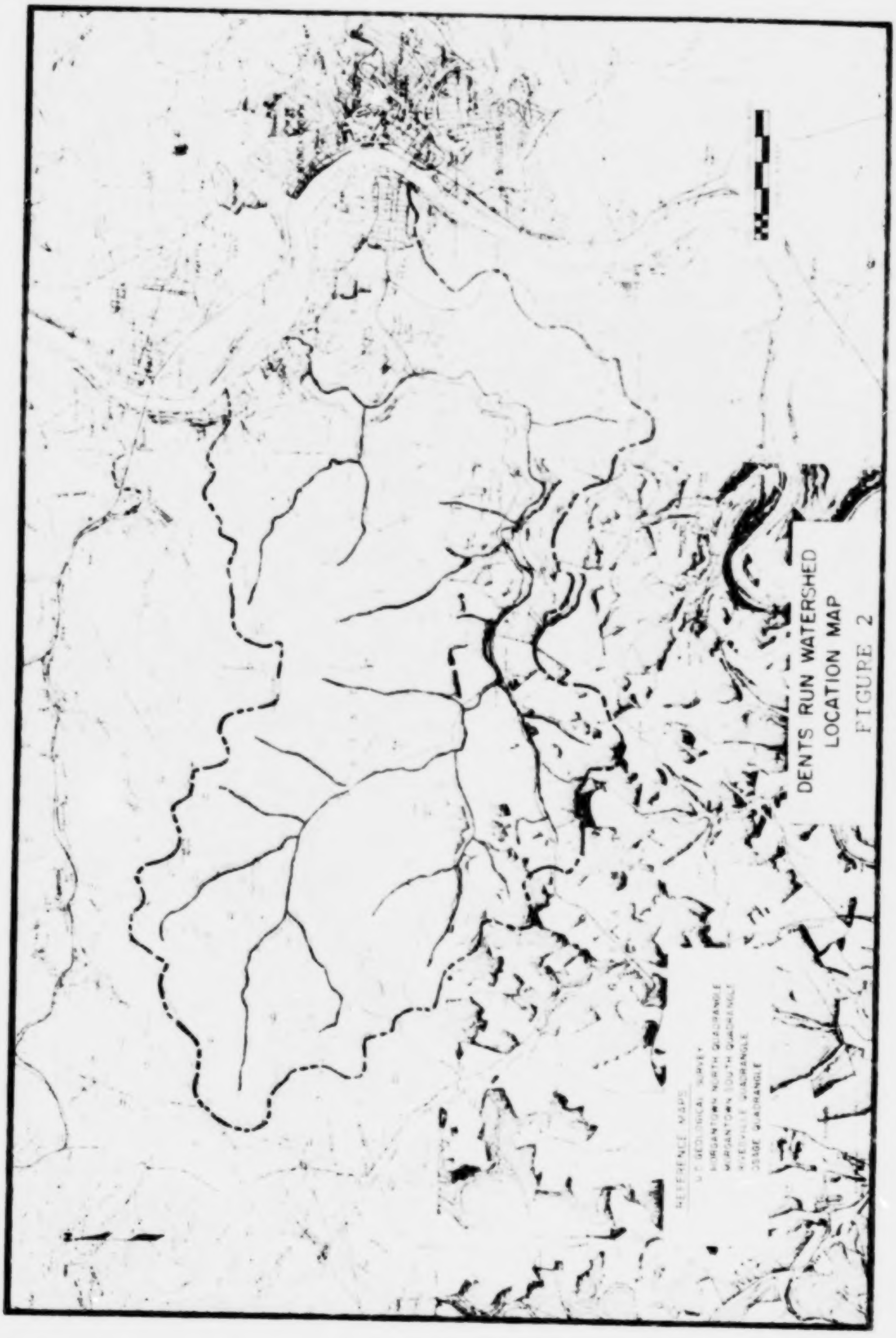
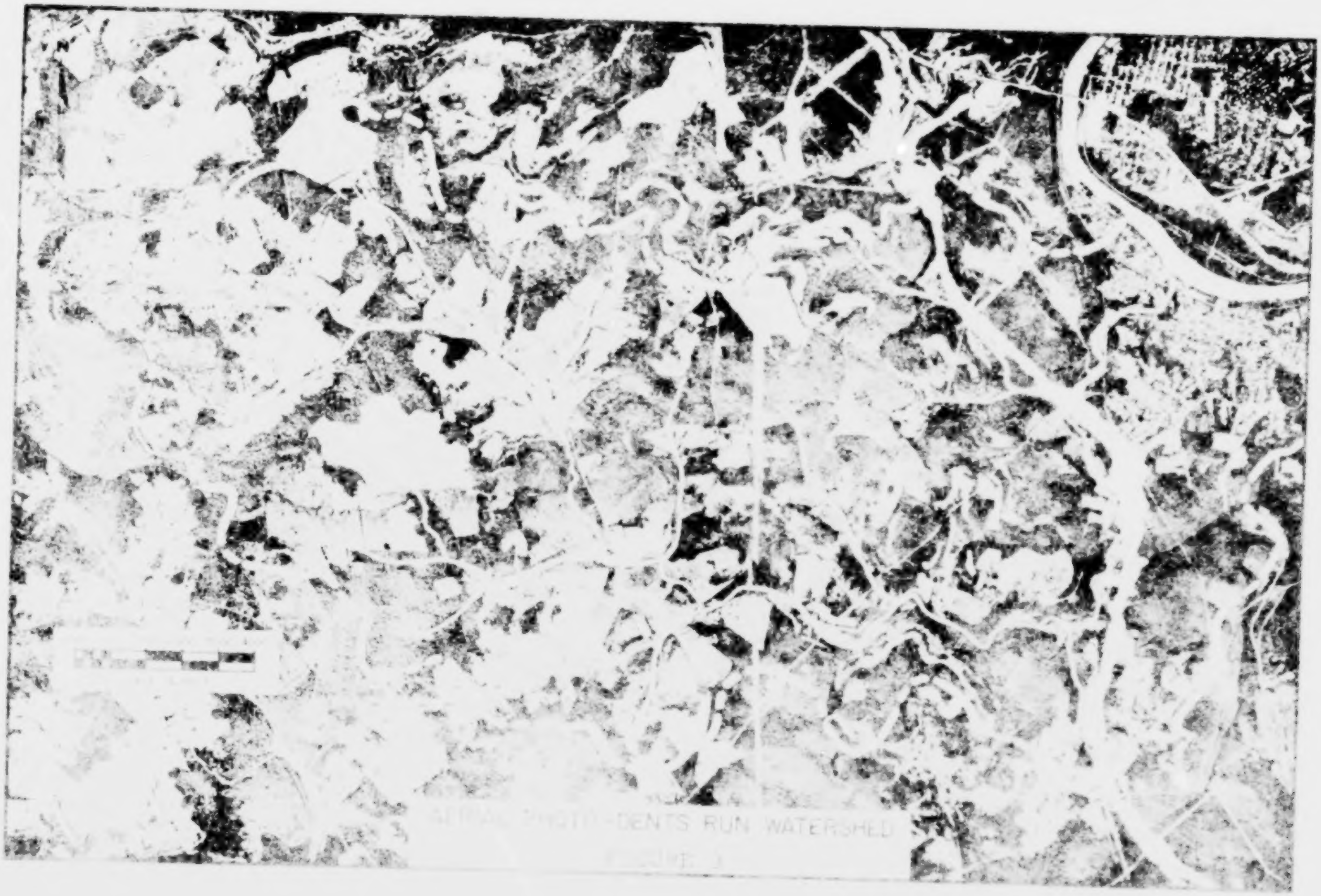

REFERENCE MAPS
U.S. GEOLOGICAL SURVEY
MORGANTOWN NORTH QUADRANGLE
MORGANTOWN SOUTH QUADRANGLE
RIVESVILLE QUADRANGLE
OSAGE QUADRANGLE

DENTS RUN WATERSHED
LOCATION MAP
FIGURE 2



AERIAL PHOTO-DENTS RUN WATERSHED

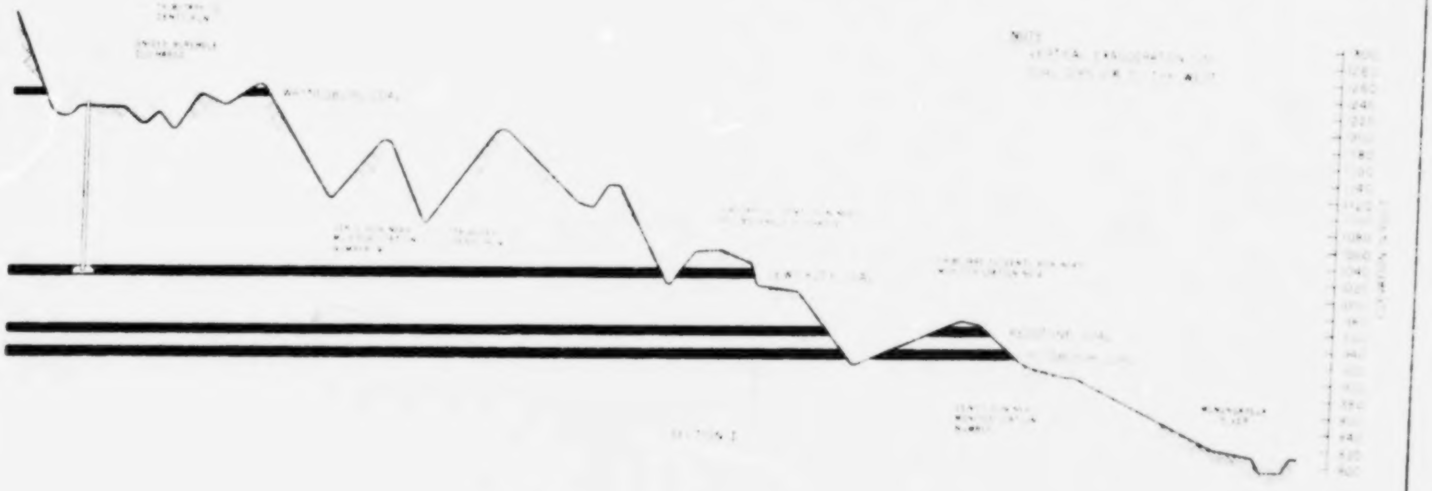
FIGURE 3

feet, so the Pittsburgh seam is 350 feet below the valley floor at this point. A typical cross section of the watershed is depicted in Figure 4.

Surface mining of the Pittsburgh-Redstone-Sewickley seams is thus confined largely to the eastern end of Dents Run Watershed with surface mining of the Waynesburg outcrop occurring near the hilltops throughout the watershed. The only drift mining noted in the Waynesburg seam is a few house coal entries. The Pittsburgh seam and the Sewickley seam have been drift mined extensively in the eastern end of the watershed for many years. Surface mining of these and the Redstone outcrop has also occurred in the eastern end of the watershed and was substantially completed prior to 1952. Some additional activity of surface mining of these seams has taken place between 1960 and 1966. Since 1966, the additional surface mining has been in the Waynesburg seam, particularly in the area around Chisler's Knob.

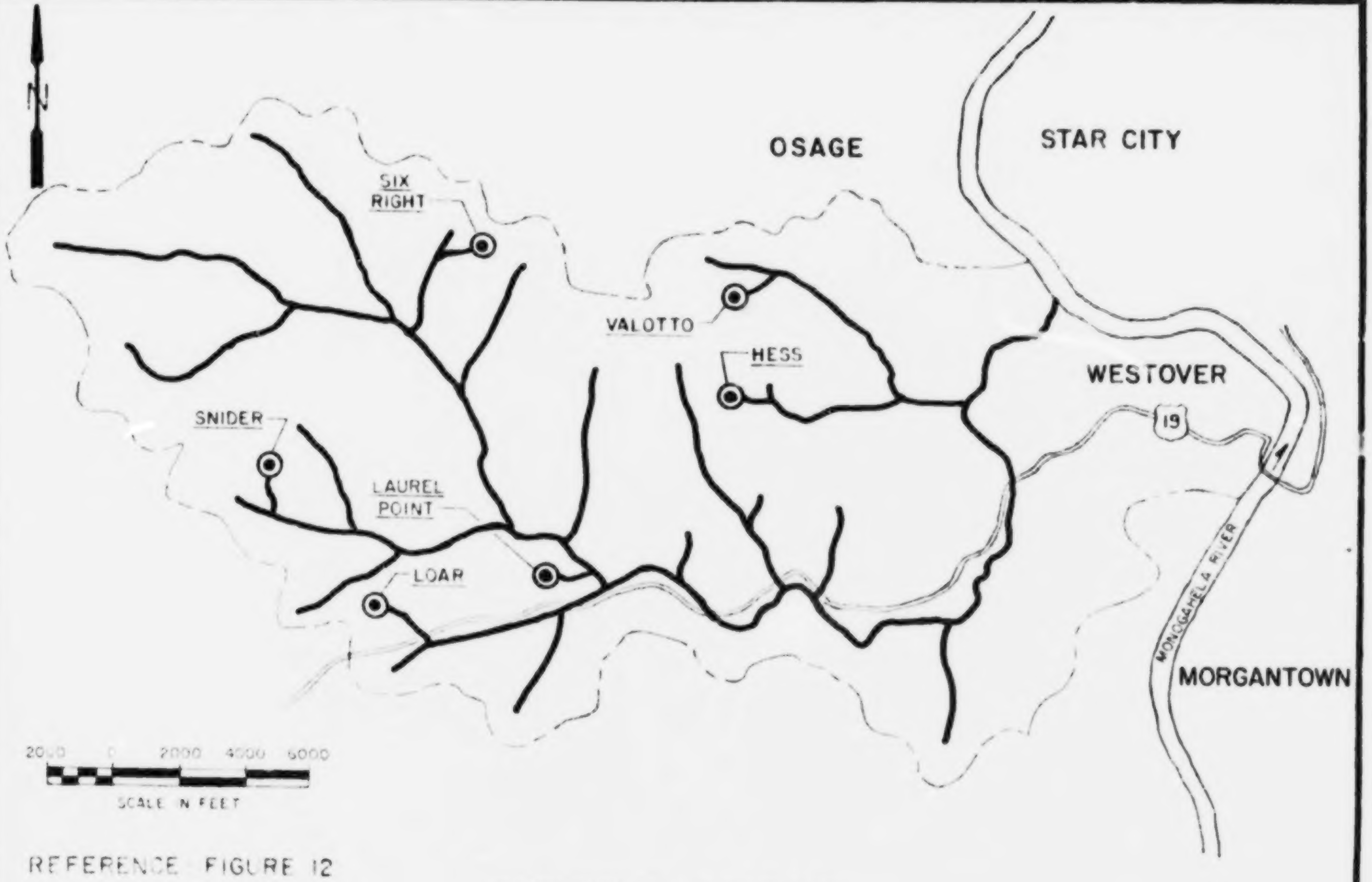
The Christopher Coal Division of the Consolidation Coal Company maintains six active borehole discharges within the watershed (see Figure 5). Five of the six boreholes discharge water from active or inactive deep mine workings within the Pittsburgh coal seam. These pumps are located within the mine; two of these, the Valotto and the Laurel Point, are constant discharge pumps. The Hess, Six Right and Loar pumps are float controlled. Surface water which is intercepted by abandoned unreclaimed mining operations in the eastern portion of the watershed drains to the Hess discharge point and then continues on to Laurel Point. The Laurel Point pumping facilities handle a small portion of this drainage, while the excess continues on to either the Loar or Six Right discharge points. A typical section of this area is illustrated in Figure 6.

The sixth borehole, Snider, discharges water from the abandoned workings of the Brock mine which is located in the Sewickley coal seam. The Snider discharge represents the largest single discharge within the watershed with an average daily pumping rate ranging between 0.3 million gallons in the dry season to 3.5 million gallons during the winter and spring months. The Snider borehole employs a float controlled surface pump; accurate pumping records are available for the Snider discharge since 1966 and can


WAYNESBURG COAL
NOTE
REDSTONE COAL
MONONGAHELA RIVER

TYPICAL CROSS SECTION
DENTS RUN WATERSHED

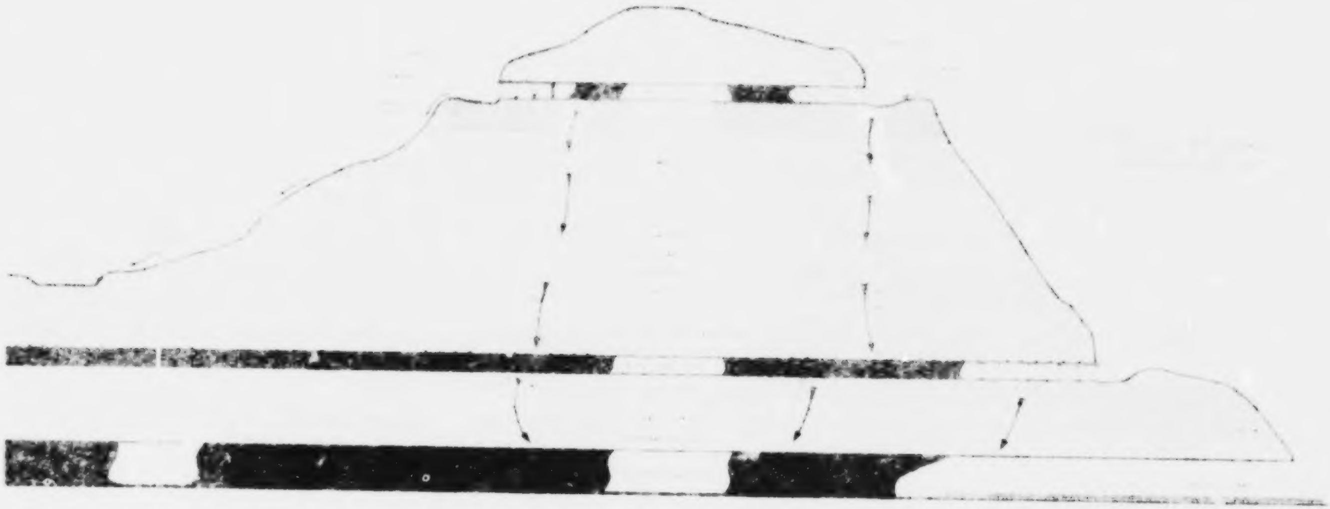
FIGURE 4


N
OSAGE
STAR CITY
SIX RIGHT
VALOTTO
HESS
WESTOVER
19
SNIDER
LAUREL POINT
LOAR
MONONGAHELA RIVER
MORGANTOWN
2000 0 2000 4000 6000
SCALE IN FEET

REFERENCE FIGURE 12

BOREHOLE LOCATIONS

FIGURE 5



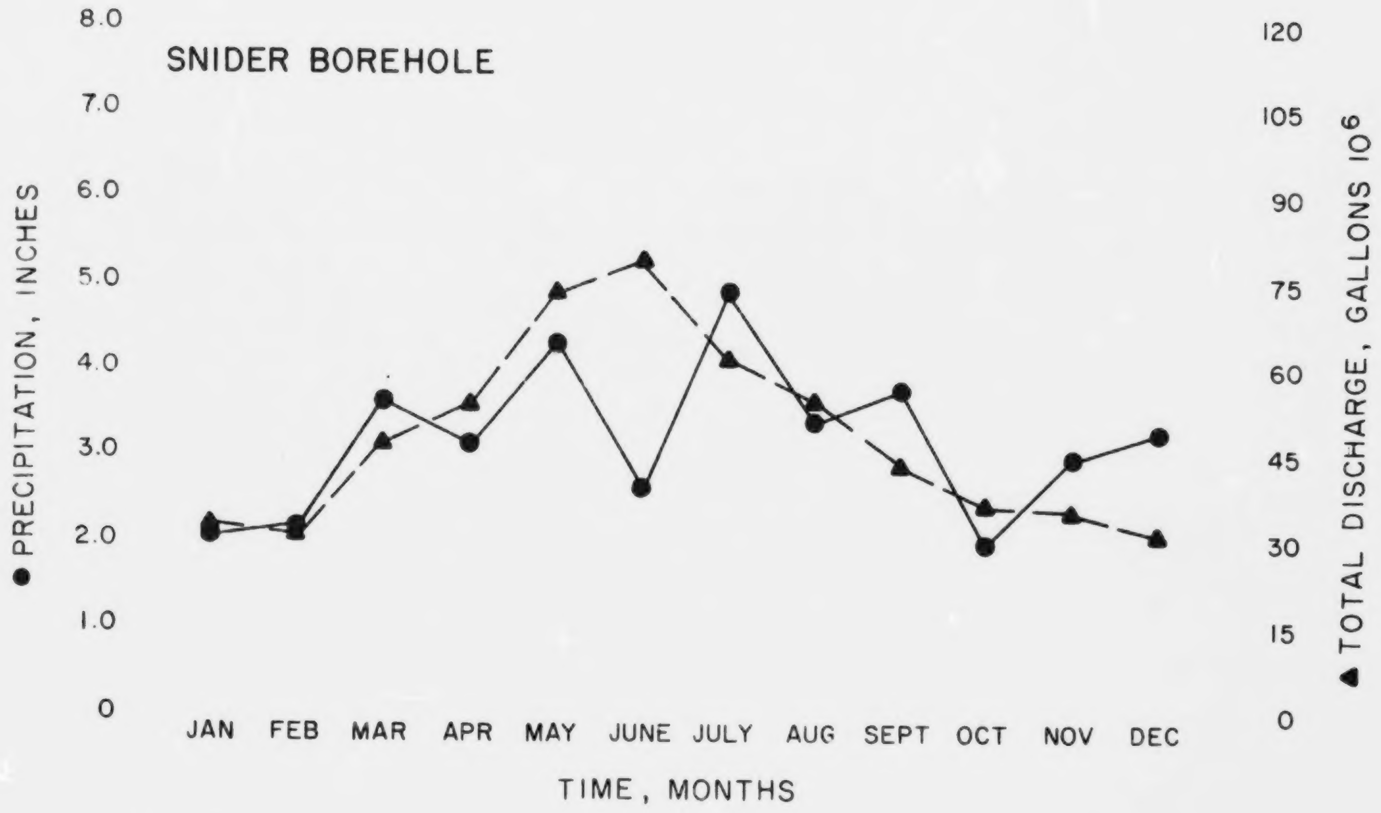
SECTION I
NORTHEAST AREA
OF WATERSHED

FIGURE 6

be correlated against recorded rainfall data for this same period. The graphical correlation between pumping rates and precipitation as illustrated in Figure 7 is typical of the Snider borehole discharge.

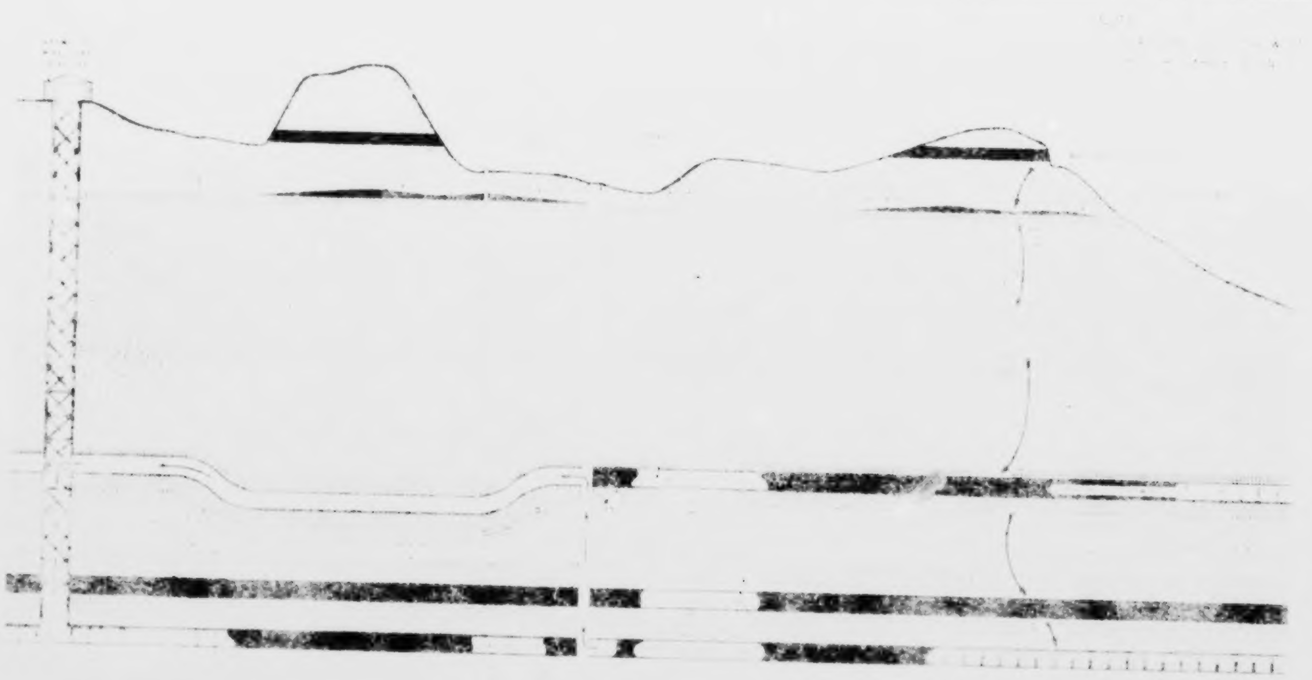
Typically, water discharged from the Sewickley coal seam is alkaline in nature. When acid water does appear at the Snider borehole, it is thought to come from an old abandoned mine in the Pittsburgh seam which fills up and is forced upward into the Sewickley seam through abandoned boreholes and fracture zones. Drainage accumulates in a swag at the Snider borehole location and is pumped to the surface to prevent overflow of the swag with consequent flooding into the Arkwright mine shaft and Pittsburgh coal workings (see Figure 8). Although this portion of the Arkwright mine is inactive with no prospects of reopening, the present seals between the inactive and active portions of the mine are not adequate to permit flooding of the inactive section without affecting active operations. Due to the unavailability of land at the present borehole site, Christopher Coal is planning to move the location of this borehole discharge to a point just outside the watershed; it is believed that the same swag can be used as a subsurface retention pond (refer to Figure 8). While this discharge will be removed from the Dents Run Watershed, the borehole will still be available as a reference point to determine the effectiveness of the reclamation work completed in reducing surface water infiltration.

Christopher Coal discharges water into Dents Run at the average rate of 3.0 million gallons per day. While this comprises the vast majority of the acid mine drainage within the watershed, several abandoned mines also have either continuous or seasonal drainages. During the dry season of the year, this flow generally amounts to a total volume of less than 25 gallons per minute from an estimated 20 to 25 drift mine openings. During periods of relatively wet weather, this flow may increase by a factor of ten. In addition to these near continuous drainages, one drift mine entry has a seasonal discharge which has been measured at 500 gallons per minute (mine opening 38, Strip Area M). According to one local resident, this discharge is quite seasonal and did not exist until the time when Strip Areas Q and R in Section G were developed. Practically all



AVERAGE PRECIPITATION & PUMPING RATE VS TIME
1966 THRU 1971

FIGURE 7



ENLARGED SECTION
DENTS RUN
WATERSHED

FIGURE 8

surface water runoff in these strip areas is channeled into auger and drift mine openings and, apparently, a considerable portion of this water drains through interconnections in the deep mine workings to finally discharge at this point. It is anticipated that this drainage, as well as the drainage from other drift mine openings in the watershed, will be significantly reduced with effective surface mine reclamation.

Water Resources

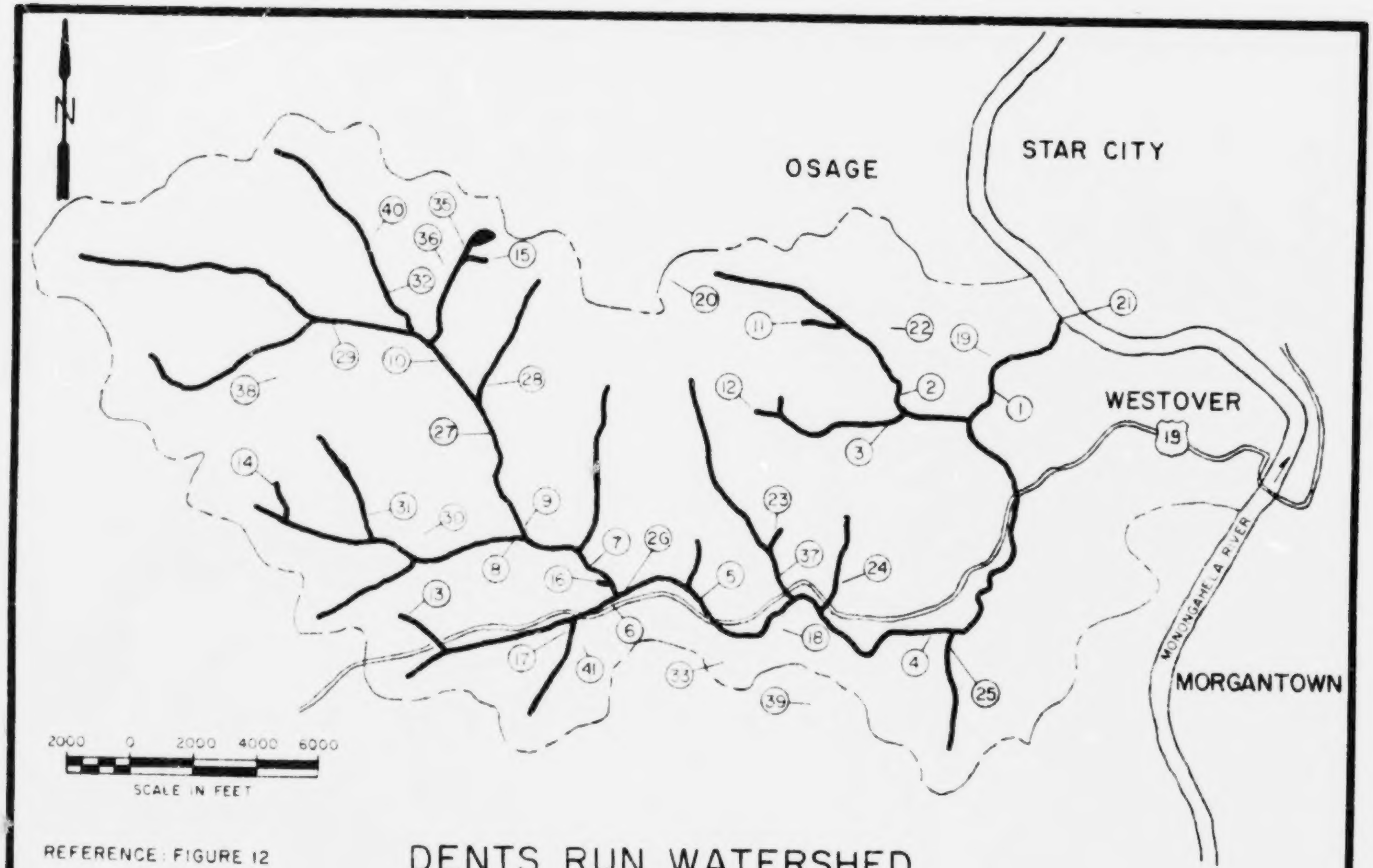
The Dents Run Watershed drains an area which is characterized by a heavy concentration of strip mines, drift mines, refuse dumps and spoil banks which contribute significantly to the acid mine drainage problems inherent in the subject stream and many of the State waters.

Waters were sampled at various locations throughout the watershed and were found, in most instances, to be highly acidic and exhibiting significant concentrations of iron, sulfate and dissolved solids, as well as high specific conductance. Such levels of concentration, in most cases, were beyond adopted standards and generally accepted limits. The geographic locations of these sample points are illustrated in Figures 9 and 12. The results of these analyses are reported in Tables 5 through 43 which appea in the Appendices of this report.

Based upon the volume and quality of the discharges from Consolidation Coal Company alone, there is an average daily discharge of 48 tons of sulfate, or 17,500 tons per year. The Monongahela River at Star City (approximately 1.0 mile downriver from the confluence of Dents Run and the Monongahela River) reportedly carries an average sulfate concentration of 371 ppm or 1262 tons per day, which is twice the load o that measured upriver at Fairmont, West Virginia. The marked increase in load was due to the contribution from tributaries such as Booths Creek, Deckers Creek, Scotts Run, Robinson Run and Dents Run.

The local streams that are continuously affected by acid mine drainage are identified on the drainage map illustrated in Figure 10.

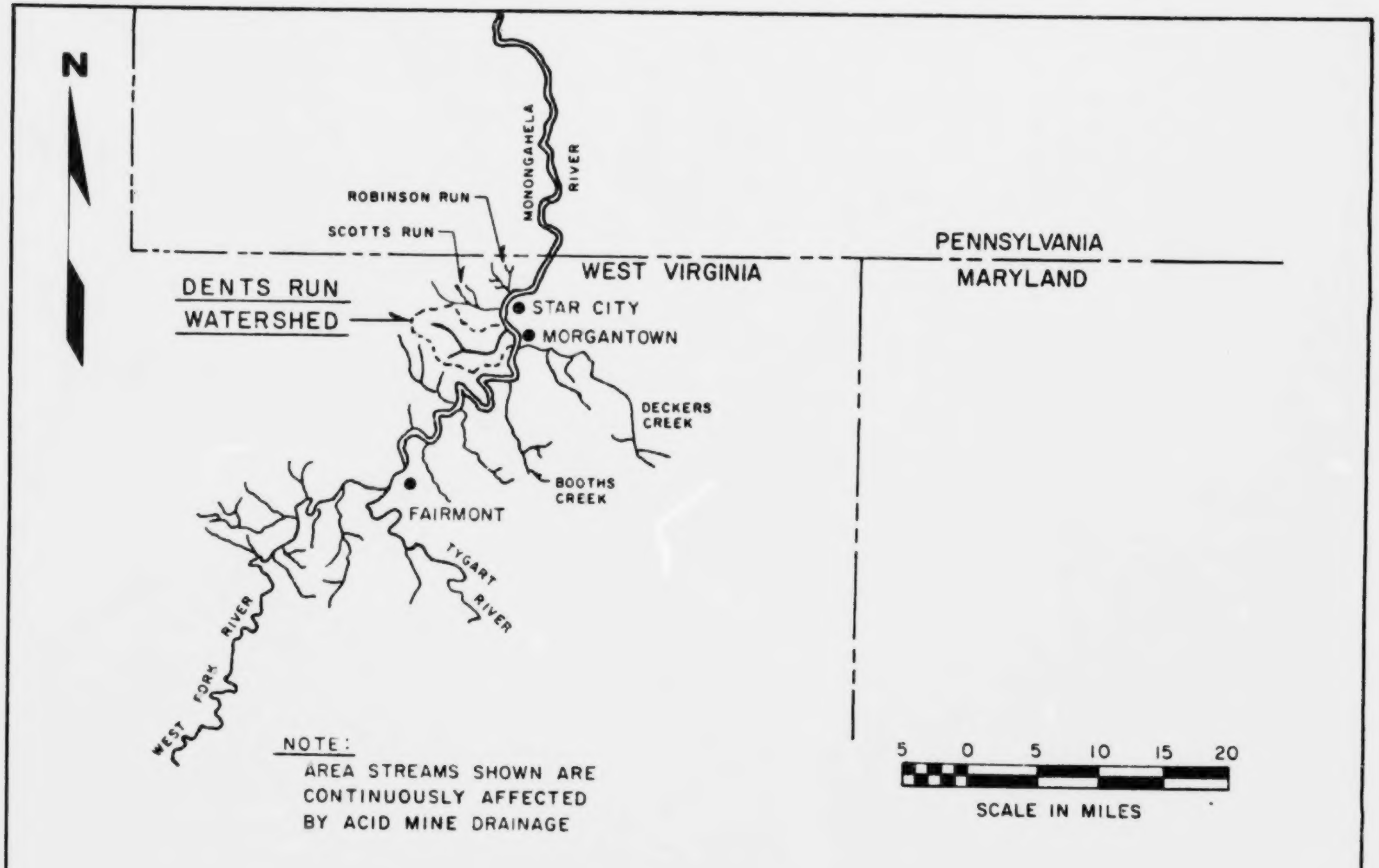
The investigation of the watershed, Dents Run and its tributaries verified that the watershed consisted of an


N
OSAGE
STAR CITY
WESTOVER
19
MONONGAHELA RIVER
MORGANTOWN
1
2
3
4
5
6
7
8
9
10
11
12
3
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
35
36
37
38
39
40
41
2000 0 2000 4000 6000
SCALE IN FEET

REFERENCE: FIGURE 12

DENTS RUN WATERSHED
SAMPLE POINT LOCATIONS

FIGURE 9


N
MONONGAHELA RIVER
ROBINSON RUN
SCOTTS RUN
DENTS RUN WATERSHED
WEST VIRGINIA
PENNSYLVANIA
MARYLAND
STAR CITY
MORGANTOWN
DECKERS CREEK
BOOTHS CREEK
FAIRMONT
TYGART RIVER
WEST FORK RIVER
5 0 5 10 15 20
SCALE IN MILES

NOTE:
AREA STREAMS SHOWN ARE
CONTINUOUSLY AFFECTED
BY ACID MINE DRAINAGE

DRAINAGE MAP
FIGURE 10

area of 9097 acres and contained 24 miles of streams. These results are tabulated in Tables 1 and 2 and are illustrated in Figure 11.

A tabulation of rainfall data for the period 1960 through 1971 is presented in Table 3. This data represents precipitation recorded at the Morgantown FAA Airport, which is located approximately 1.0 mile east of the Dents Run Watershed. A recording rain and snow gauge should be installed near the center of the watershed to obtain a more accurate appraisal of the actual rainfall within this area.

Social and Economic Environment

The project area is located within Monongalia County, West Virginia, and lies due west of the City of Morgantown. Points of major interest comparing the State to national trends are as follows:

1. During the decade from 1960 to 1970, West Virginia was one of three states in the nation losing population. Of the three, it had the greatest numerical decline and rate of decline. The State's population dropped 6.2% during the decade.

2. West Virginia is the only State which lost population during two successive decades. The population loss from 1950 to 1960 was 7.2%.

3. The metropolitan population within the State is 31% compared to a national average of approximately 67%.

4. The State has proportionately more teenagers as a segment of its total population than the national average.

5. The proportion of adults in the State who have completed one or more years of college is lower than the national average.

A significant reason for the general decline in population in the State is due primarily to increased mechanization in the coal industry and this reduction in employment

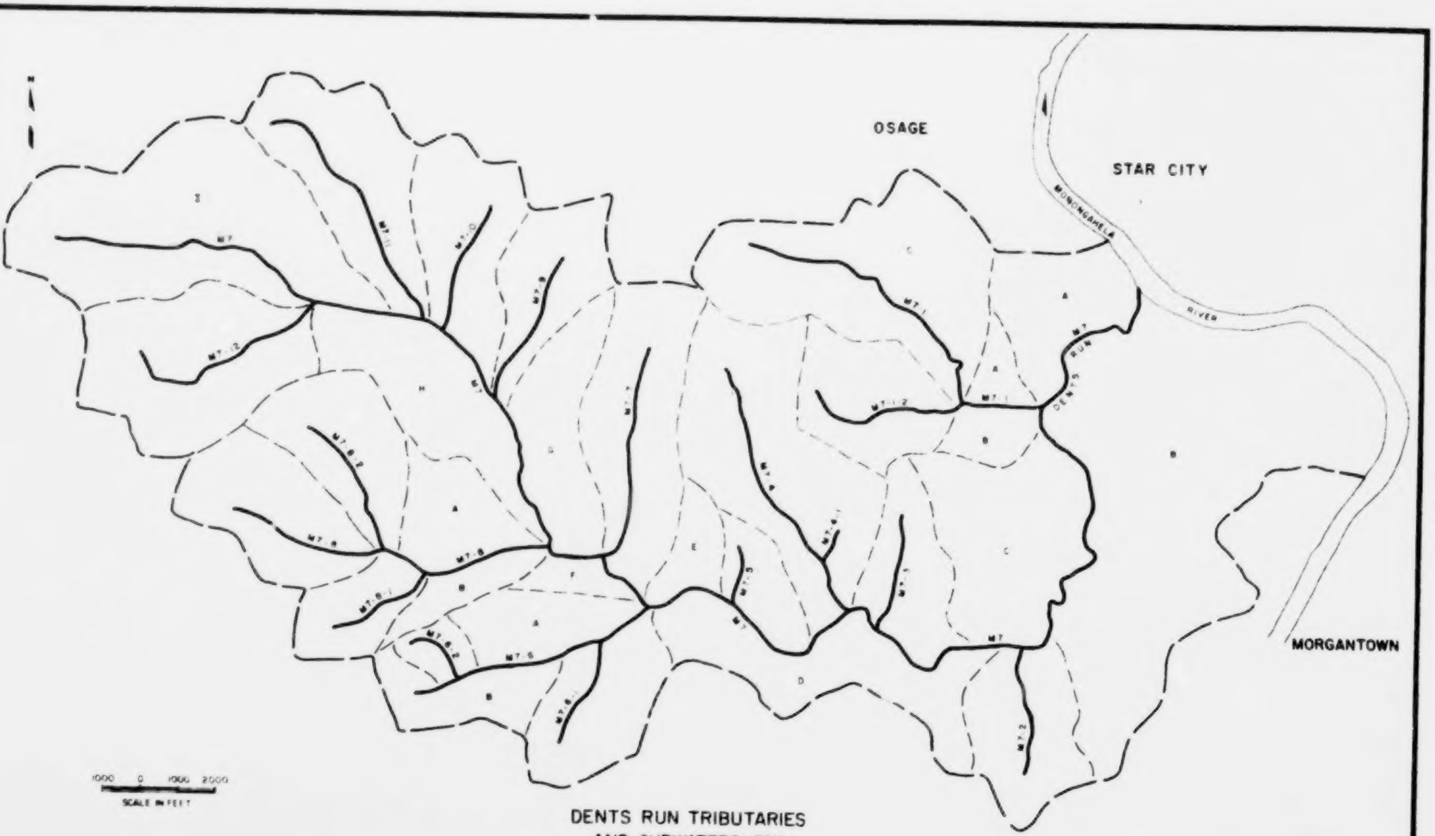
TABLE 1
TABULATION OF STREAM LENGTHS

Stream Identification No.	Length
M7-Dents Run	8.50 Mi.
M7-1	1.90 Mi.
M7-1-2	0.85 Mi.
M7-2	0.66 Mi.
M7-3	0.61 Mi.
M7-4	1.37 Mi.
M7-4-1	0.09 Mi.
M7-5	0.28 Mi.
M7-6	1.23 Mi.
M7-6-1	0.57 Mi.
M7-6-2	0.34 Mi.
M7-7	1.06 Mi.
M7-8	1.61 Mi.
M7-8-1	0.09 Mi.
M7-8-2	0.53 Mi.
M7-8-3	0.72 Mi.
M7-9	0.75 Mi.
M7-10	0.66 Mi.
M7-11	1.23 Mi.
M7-12	1.08 Mi.
	24.13 Mi.

TABLE 2
TABULATION OF SUBWATERSHED AREAS

Subwatershed Number	Area Acres	Subwatershed Number	Area Acres
M7-A	226.12	M7-5	118.06
M7-B	1270.66	M7-6-A	159.05
M7-C	404.95	M7-6-B	147.57
M7-D	350.78	M7-6-1	244.32
M7-E	89.20	M7-6-2	54.11
M7-F	57.39	M7-7	395.18
M7-G	255.73	M7-8	291.87
M7-H	314.83	M7-8-A	170.53
M7-I	716.58	M7-8-B	88.38
M7-1-A	59.03	M7-8-1	144.30
M7-1-B	75.42	M7-8-2	259.08
M7-1-C	588.67	M7-9	221.36
M7-1-2	252.52	M7-10	285.32
M7-2	254.16	M7-11	373.86
M7-3	209.89	M7-12	457.49
M7-4	560.80		

TOTAL ACRES - 9097.21


OSAGE
STAR CITY
MONONGAHELA
RIVER
DENTS RUN
MORGANTOWN
N
M7
M7-1
M7-1-2
M7-2
M7-3
M7-4
M7-4-1
M7-5
M7-6
M7-6-1
M7-6-2
M7-7
M7-8
M7-8-1
M7-8-2
M7-9
M7-10
M7-11
M7-12
1000 0 1000 2000
SCALE IN FEET

DENTS RUN TRIBUTARIES
AND SUBWATERSHEDS

FIGURE 11

TABLE 3

TABULATION OF RAINFALL DATA, MORGANTOWN FAA AIRPORT

1960 THROUGH 1971

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YR.TOT.
1960	2.39	3.29	1.98	1.76	4.97	2.05	4.94	3.59	3.10	2.84	1.40	1.62	33.93
1961	1.41	3.21	5.80	4.42	2.84	6.87	5.58	3.91	4.29	3.00	3.44	3.25	48.02
1962	2.67	3.99	4.15	4.82	1.92	2.21	2.73	2.84	4.10	3.22	3.34	3.15	39.14
1963	1.42	1.62	6.55	1.45	1.36	5.35	1.39	3.41	1.90	0.24	3.92	0.92	29.53
1964	2.14	2.38	3.91	4.66	1.25	4.62	3.91	4.77	3.44	0.86	3.50	4.30	39.74
1965	3.04	1.31	3.42	3.57	1.29	2.27	3.93	3.05	4.62	1.88	1.58	0.61	30.57
1966	3.60	3.32	1.04	4.51	1.47	0.87	3.13	3.77	3.45	1.71	3.83	1.71	32.41
1967	0.61	2.08	7.29	2.92	6.54	1.56	4.23	3.25	3.87	2.60	2.91	3.11	40.97
1968	1.95	0.63	4.11	1.84	7.47	2.88	2.10	3.84	3.09	1.77	3.65	2.91	36.24
1969	1.56	0.82	1.76	3.43	2.67	2.37	8.71	2.23	2.05	1.47	2.43	4.44	33.94
1970	1.63	1.84	4.54	4.81	2.59	4.26	4.91	3.36	3.69	3.15	1.86	5.31	41.95
1971	2.84	4.08	2.80	1.14	4.86	3.63	6.20	3.60	6.42	1.14	3.25	2.09	42.05
TOT.	25.26	28.57	47.35	39.33	39.23	38.94	51.76	41.62	44.02	23.88	35.11	33.42	448.49
AVE.	2.11	2.38	3.95	3.28	3.27	3.25	4.31	3.47	3.67	1.99	2.93	2.79	37.37

has not been offset by increases in other sectors of the State's economy. Although the general State population trend is a decline, some areas of the state are experiencing a growth in population. This represents a shift from rural to metropolitan areas which is in evidence in the towns and cities within Monongalia County, most of which are small in size. Population changes (1960-1970) have ranged from +6 to 7% for Star City and Westover to +27 to 31% for Granville and Morgantown. It is further evidenced by an accompanying increase in population (13.3%) within the County itself.

Pertinent facts relative to the population density are as follows:

State of West Virginia (1969 figures)

population/square mile - 75.5

Monongalia County (1970 figures)

land area - 365 square miles
total population - 63,714
population/square mile - 174.6

The State is running opposite to national figures (1970) when it comes to data on population increases in various age groupings. Nationwide, people in the age groups 5 to 14 and 25 to 44 are increasing in number; however, in West Virginia, people in these same groups show a decline of 15%.

Other statistics (1960) on the population in the State reveal that more than half of the State's employed workers are in blue-collar occupations, and that one-third of the families in the State have incomes under $3,000. This is significant since the State does not experience increased population, as almost all other states, and those that are native born tend to remain in the state of their birth. People in the area are definitely dependent upon employment in the vicinity of their home, since a low percentage of the work force (8.2%) tends to work outside the county of their residence. The median level of education for the people in the County was 8.6 years of school completed.

Agricultural employment represents a very small portion of the State's economy as evidenced by a total value of $92 million of farm products sold in a year (1964). Farms are relatively small in size (153 average acres/farm); the most prevalent types of farming are dairy, poultry and livestock and the major crops are hay, apples, corn and tobacco. The major sector of the economy is in the area of non-agricultural work. The bulk of the labor force in this area is engaged in manufacturing industries, the wholesale and retail trades, or government service. However, even though the mining industry represents a smaller number of jobs in the ranking, it commands recognition as a major force in the control of the economy.

Mineral production in the State is of great importance since West Virginia has been ranked fifth in the nation, according to 1968 statistics. The order of importance of those minerals in terms of value is coal, natural gas, stone and natural gas liquids. In Monongalia County, coal was considered first and stone second, in order of value, of the minerals produced. The foregoing is understandable when you consider that coal represented 85% of the State's mineral output during 1969.

The coal industry naturally has a dominant effect on growth and the economy within the State. Counties experiencing declining population are those heavily dependent upon the coal industry for support of their economy, a result of greater mechanization in the industry.

Statistics (1969) on the coal industry, in total for the State, reveal that mining employment went up 3.3% from the previous year and the value of the coal mined that year represented a 4% increase over the previous year ($807.8 million). Of the total coal produced in the State, 86% came from 867 underground operations, 10% from 229 strip mines and 4% from 111 auger mines. Within Monongalia County, 24 underground mines and 13 strip mines were in operation, producing a total value of $53.8 million worth of coal production.

Although a diversity of areas exist for employment within the State and notable industries may dominate the economy, the factors of minimal education, increased mechanization, predominance of employment in blue-collar positions, and dependence on employment in the vicinity of the home are significant factors indicating the limited potential of the work force. This is further supported by relatively high unemployment rates (1960) in Monongalia County and the towns in its jurisdiction as follows:

Monongalia County - 8.9% of civilian labor force unemployed

Westover - 6.2% of civilian labor force unemployed

Morgantown - 6.1% of civilian labor force unemployed

Workers are dependent primarily on work in the mining industry, manufacturing and government services within Monongalia County. The need for increased job opportunities is critical from the standpoint that the median age of the public is in the mid-to-late twenties. Statistics from the 1960 census indicated that the median income per family for Monongalia County was $5,297.

The State of West Virginia now has adequate regulations and authority to control the quality of its waters, as well as the restoration of worked land. However, conditions as they exist today are the result of years of neglect and abuse, which will take many years and a considerable investment to correct.

Concern and action to maintain and improve the State's waterways is essential to the ability of the State to reverse its pattern of years of decline during a general period of progress in most other states. Maintenance of the State's waters within the water quality standards established will make them more acceptable for the water use categories applicable to such waters. The Dents Run Watershed falls within the use standards established for the Monongahela and its tributaries, which include recreation, public water supply and industrial water supply.

Therefore, it can readily be seen that improved water quality will meet the demand for increased water use by the public as people continue to migrate to the towns and cities. It will also serve to encourage industrial investment in the area, providing more job opportunities, when industry learns that it can expect and be virtually guaranteed a good source of water to meet the demands of its operations.

One of the greatest potentials for an economic upturn in the State is in the area of recreation. West Virginia has been planning, encouraging and investing in recent years in a program which includes the development of new recreational facilities within the State and the promotion of the State as an ideal place for hunting, fishing and other vacation activities. This concerted effort has been conducted to substantially promote an existing industry and, in so doing, create many new job opportunities for residents of the State. These efforts can only be continued as new areas of the State may be opened to such development, which in some cases requires the restoration of scarified land and the improvement of water quality to support fish life and encourage pleasure boating, swimming, etc. This project can go a long way in demonstrating a successful program of restoring the natural beauty of the land and the serviceability of the waterways, which is required on an areawide basis to promote full recreational capabilities.

SECTION VI

PRELIMINARY ENGINEERING

Detailed Site Descriptions

The information presented herein includes a detailed physical description of each strip area and mine opening in the project area, as well as recommendations for reclamation work required at each site to facilitate proper execution of the project beyond this study.

Each strip area and/or mine opening presented is first listed under the section letter of the area of the watershed map in which it is located (see Figure 12). The heading identifying and describing the particular strip area or mine opening and its priority classification then precedes the paragraph concerning same. The probable coal seam is then identified in parentheses immediately below this heading. Letters are used to designate strip areas which correspond with matching lettered cross-hatched areas on the watershed map. Mine openings are identified by number and correspond to matching numbered symbols, in accordance with the legend.

A priority listing has been developed for the work to be performed. Since the objective of this demonstration project is the reduction of mine water pollution through water infiltration control, first priority items refer to those areas which contribute significant amounts of drainage to the underground mine workings, while second priority items are those which contribute directly to stream pollution as a result of surface water runoff. Third priority items are those areas which contribute to aesthetic pollution; this includes all of the sites within the watershed which are not included in the first or second priority listing. The priority listings are as follows:

Priority I - Infiltration

1. Dents Run - Suspected loss of flow
2. Section G, Strip Area R
3. Section G, Strip Area A
4. Section C, Strip Area C
5. Section G, Strip Area J
6. Borehole - Interception(s)

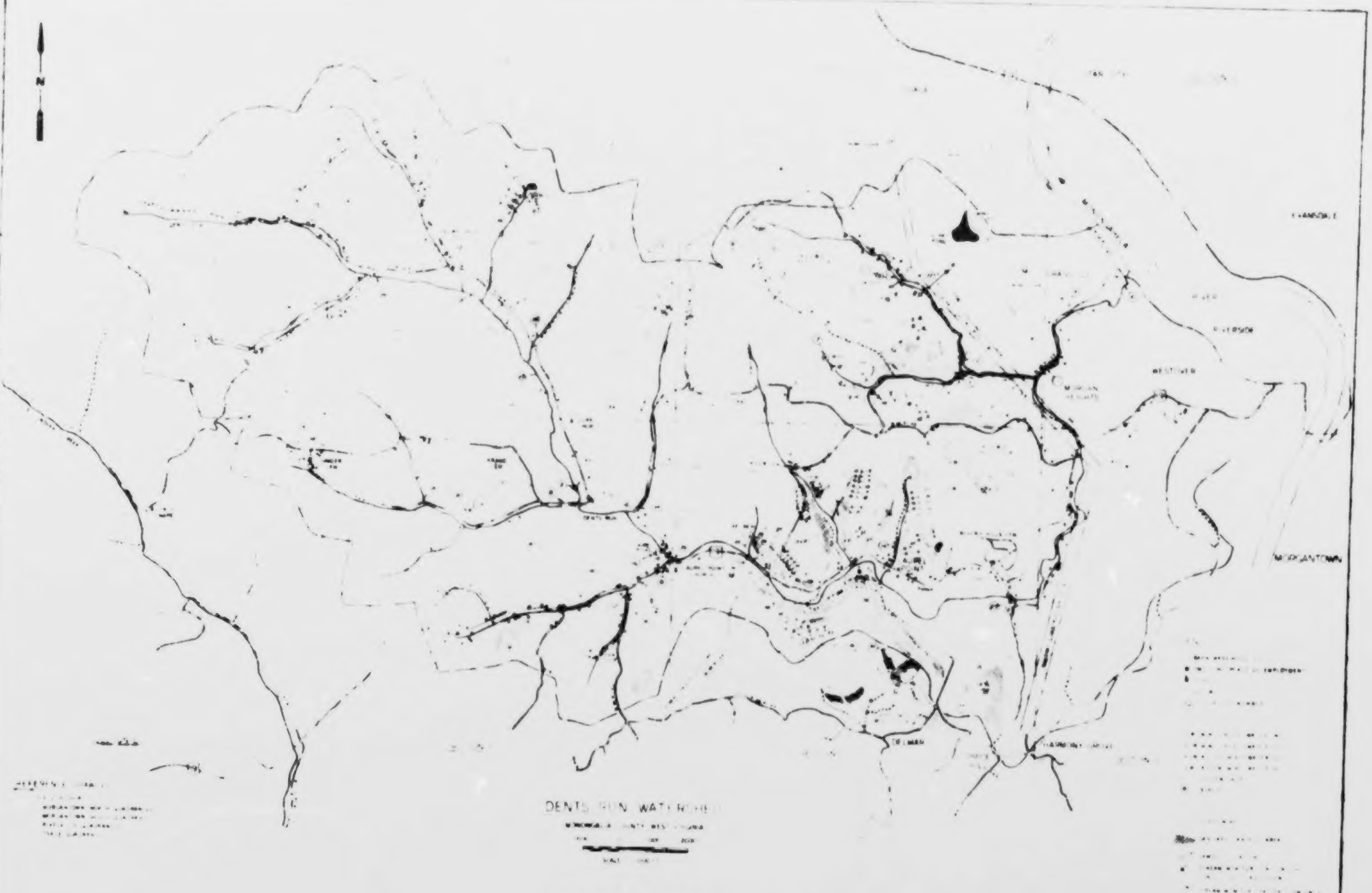

N
DENTS RUN WATERSHED
MORGANTOWN
WESTOVER

FIGURE 12

Priority II - Surface Water Pollution

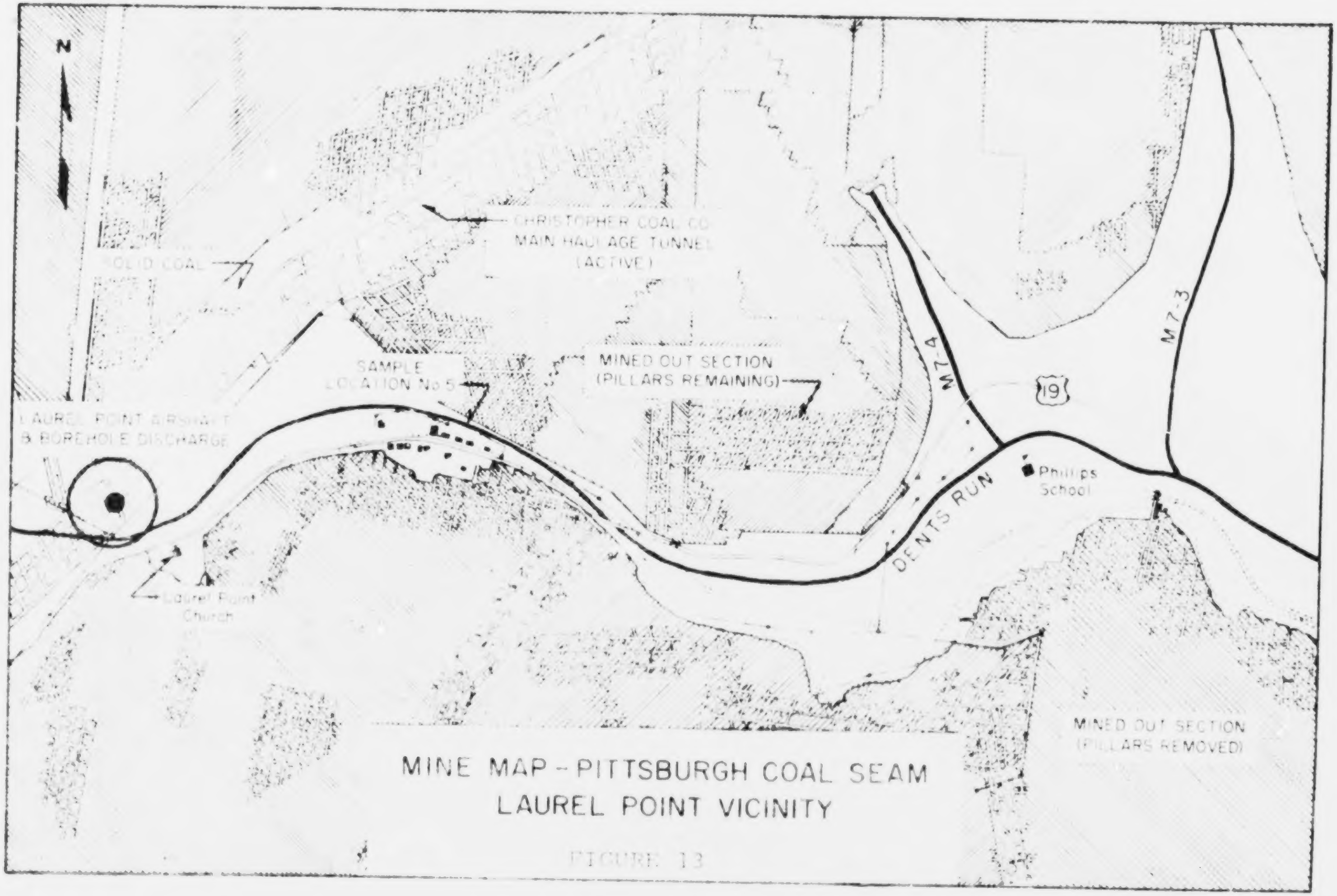
1. Section G, Strip Area G
2. Section G, Mine Dump N
3. Section C, Strip Areas J and H
4. Section G, Strip Areas D and E
5. Section G, Strip Area M
6. Section G, Strip Area C
7. Section F, Strip Area A
8. Section C, Strip Area S
9. Section G, Strip Areas P and Q
10. Section G, Strip Area B
11. Section C, Strip Area B

Priority III - Aesthetic Pollution

All remaining sites in the watershed.

Items 1 and 6 under Priority I require further explanation, as they are not discussed in the site descriptions. Throughout the investigative portion of this study, significant reductions were observed in the flows measured between sample points 4 and 5 in Dents Run. Subsequent investigations have somewhat pinpointed this apparent water loss to one general area. The Pittsburgh coal seam outcrops in this area and it is believed that a portion of the stream flow finds its way into mine workings through fissures or fracture zones present in the stream bed. An extensive investigation is scheduled to be conducted during the months of May and June, 1972, to determine the exact point of water loss. If this area can be defined, it will probably be necessary to line this portion of the stream bed with concrete. Figure 13 shows the extent of mining in the Pittsburgh coal seam in this area and the proximity of the mining to the stream bed.

Discussions with Christopher Coal personnel indicate that some of the drainage that is pumped from the Snider borehole location may be the result of water rising from an abandoned mine in the Pittsburgh coal seam through abandoned boreholes and discharging into the abandoned Brock Mine in the Sewickley coal seam. The Snider borehole employs protective pumping to prevent water from building up and flowing into the Arkwright mine shaft and Pittsburgh mine workings. Figure 8 illustrates the theoretical substrata configuration and origin of subsurface water at the Snider borehole location. The



N
SOLID COAL
CHRISTOPHER COAL CO.
MAIN HAULAGE TUNNEL
(ACTIVE)
SAMPLE
LOCATION No 5
MINED OUT SECTION
(PILLARS REMAINING)
M7-4
19
M7-3
LAUREL POINT AIRSHAFT
& BOREHOLE DISCHARGE
Phillips
School
DENTS RUN
Laurel Point
Church
MINED OUT SECTION
(PILLARS REMOVED)

MINE MAP – PITTSBURGH COAL SEAM
LAUREL POINT VICINITY

FIGURE 13

suspected boreholes are believed to be in Section H (see Figure 12) near the village of Harmony Grove. If further investigation confirms this theory of interceptions, these should be sealed to prevent any future influx of water from this area.

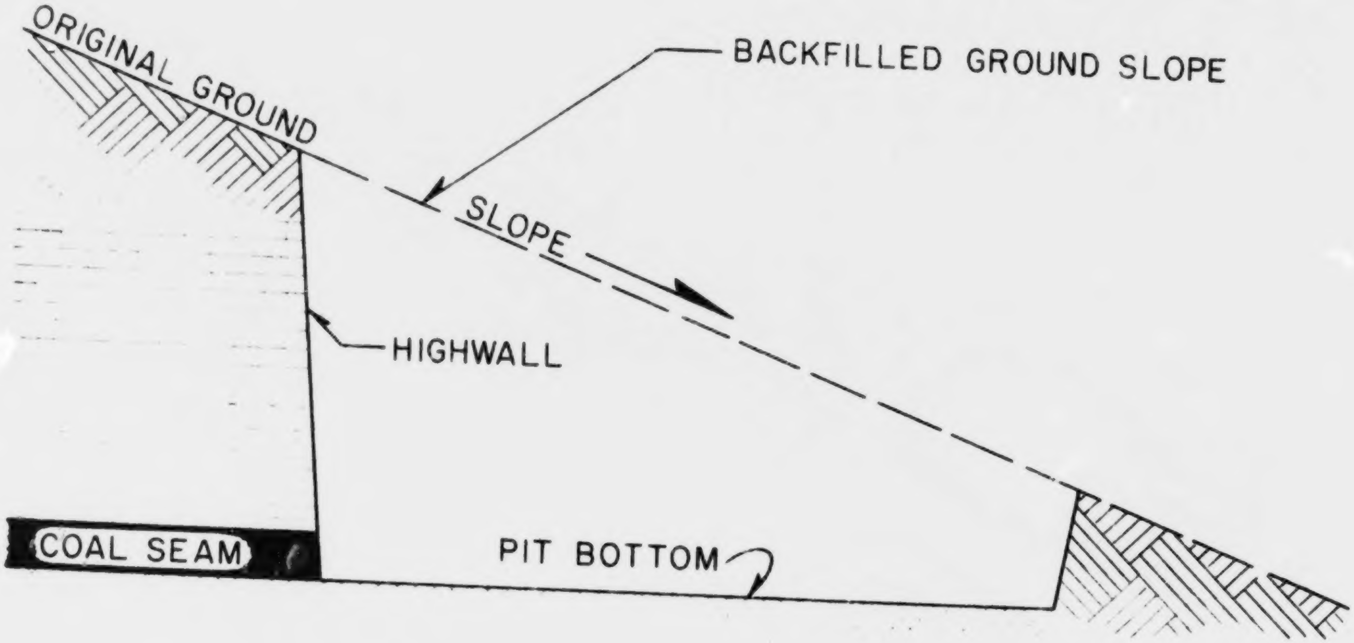
The various types of backfill methods presently employed in West Virginia are illustrated in Figures 14 through 18. Reclamation work within the watershed would be primarily concerned with the contour or pasture type backfill or a combination of these two techniques, depending upon the conditions encountered at each site. The pasture type backfill will be used when the highwall is relatively sound, whereas the contour backfill will be used in areas which have highly fractured highwalls. The backfills will be compacted in order to prevent excessive infiltration through the porous spoil material and into intercepted deep mine workings.

Where surface mines have disturbed relatively large drainage areas, surface water diversion ditches should be constructed in order to prevent excessive erosion of the backfill and permit better development of the vegetative cover. Figure 47 illustrates a typical diversion ditch.

Figures 19 and 20 show typical applications of both of these surface reclamation techniques. In the case of the auger mining, subsidence has not occurred and the highwall is relatively intact, thereby permitting the use of the pasture backfill. In Figure 19 the interception of extensive deep mine workings has resulted in fracturing of the highwall with consequent instability and relatively high infiltration rates. The compacted contour backfill and surface water diversion ditch serve both to reduce further fracturing and decrease the rate of surface water infiltration.

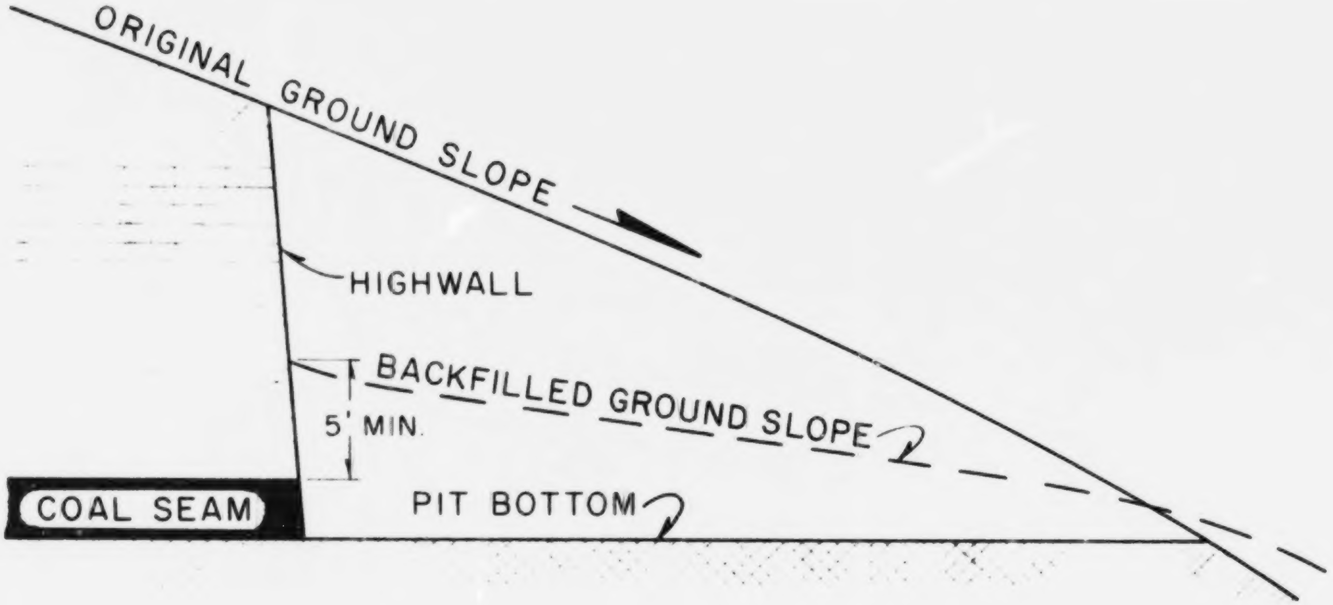
Site investigations in the Dents Run Watershed indicate that the majority of surface mines have intercepted deep mine workings, highwalls are generally highly fractured and surface water runoff in these areas is usually channeled directly into the deep mine workings.

Several of the surface mines presently contain water impoundments in portions of the unreclaimed pit areas. As reclamation work requires draining of these impoundments, portable treatment facilities will be employed to provide adequate treatment of any and all water impoundments prior to discharge to a receiving stream.


ORIGINAL GROUND
BACKFILLED GROUND SLOPE
SLOPE
HIGHWALL
COAL SEAM
PIT BOTTOM

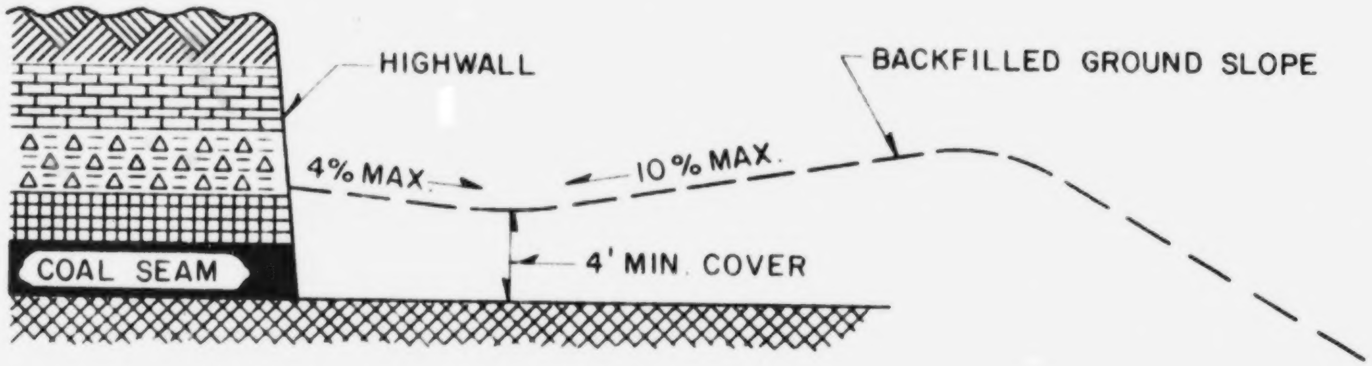
TYPICAL CONTOUR BACKFILL

FIGURE 14


ORIGINAL GROUND SLOPE
HIGHWALL
BACKFILLED GROUND SLOPE
5' MIN.
PIT BOTTOM
COAL SEAM

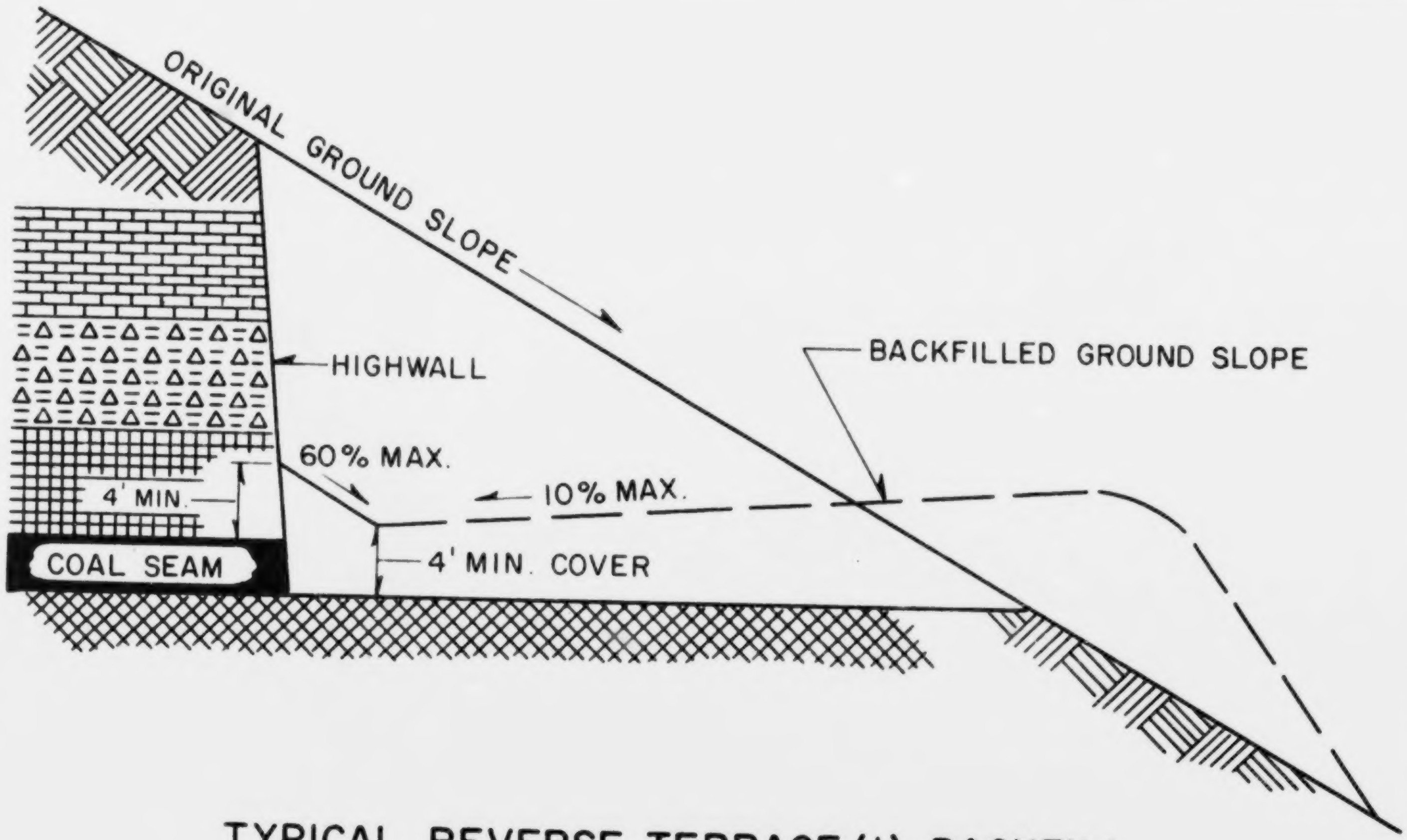
TYPICAL PASTURE BACKFILL

FIGURE 15


HIGHWALL
BACKFILLED GROUND SLOPE
4% MAX.
10% MAX.
4' MIN. COVER
COAL SEAM

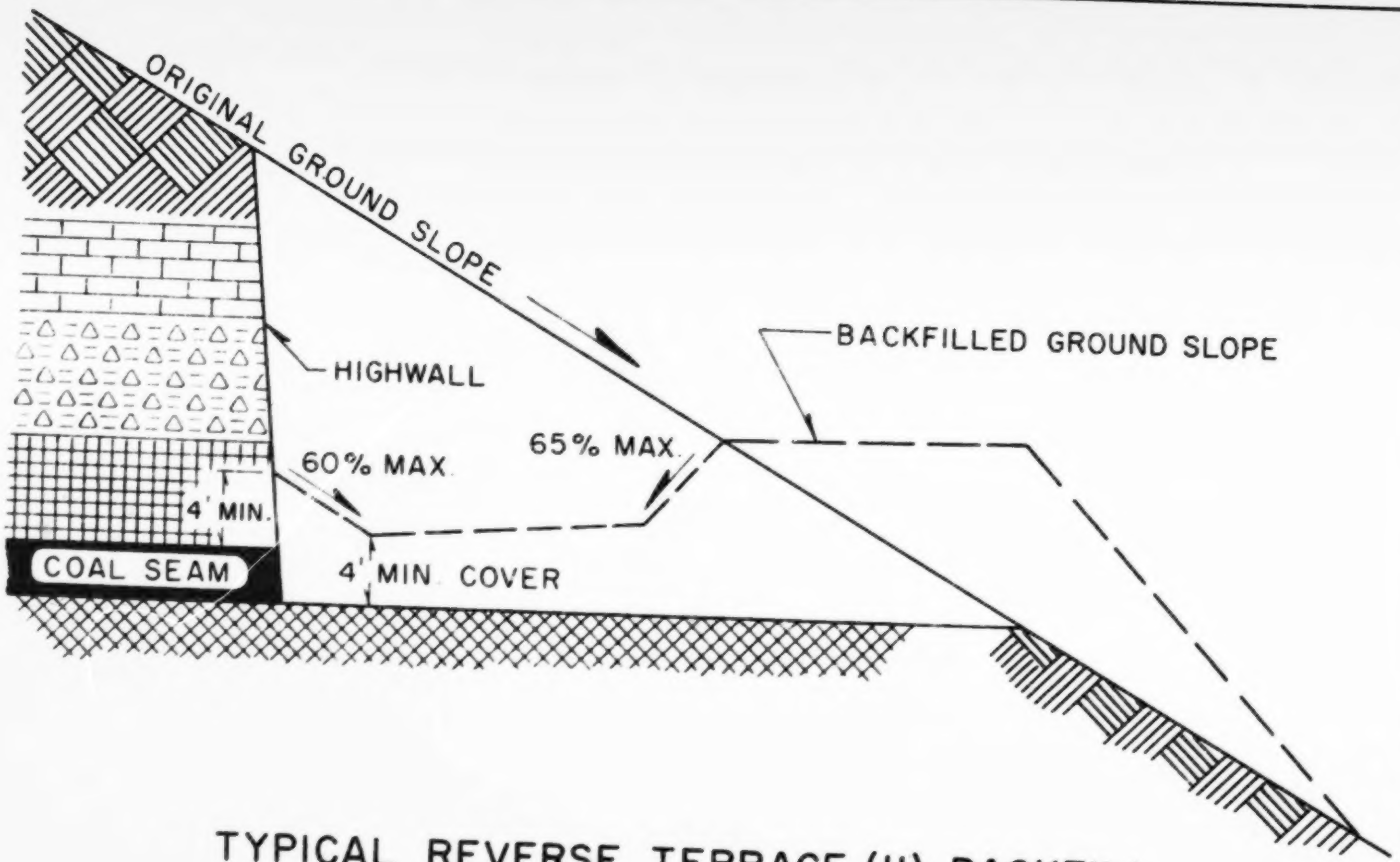
TYPICAL GEORGIA V-DITCH BACKFILL

FIGURE 16


ORIGINAL GROUND SLOPE
HIGHWALL
BACKFILLED GROUND SLOPE
60% MAX.
10% MAX.
4' MIN.
COAL SEAM
4' MIN. COVER

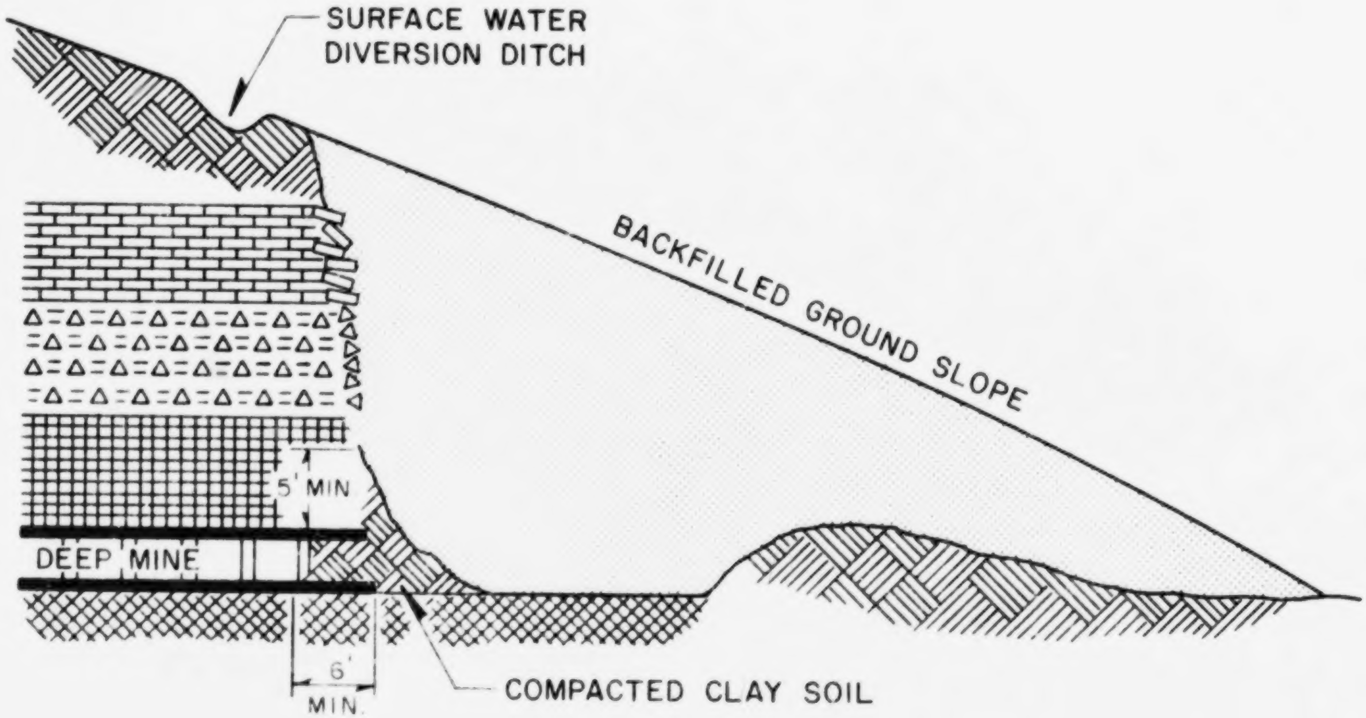
TYPICAL REVERSE TERRACE (I) BACKFILL

FIGURE 17


ORIGINAL GROUND SLOPE
HIGHWALL
BACKFILLED GROUND SLOPE
65% MAX.
60% MAX.
4' MIN.
COAL SEAM
4' MIN. COVER

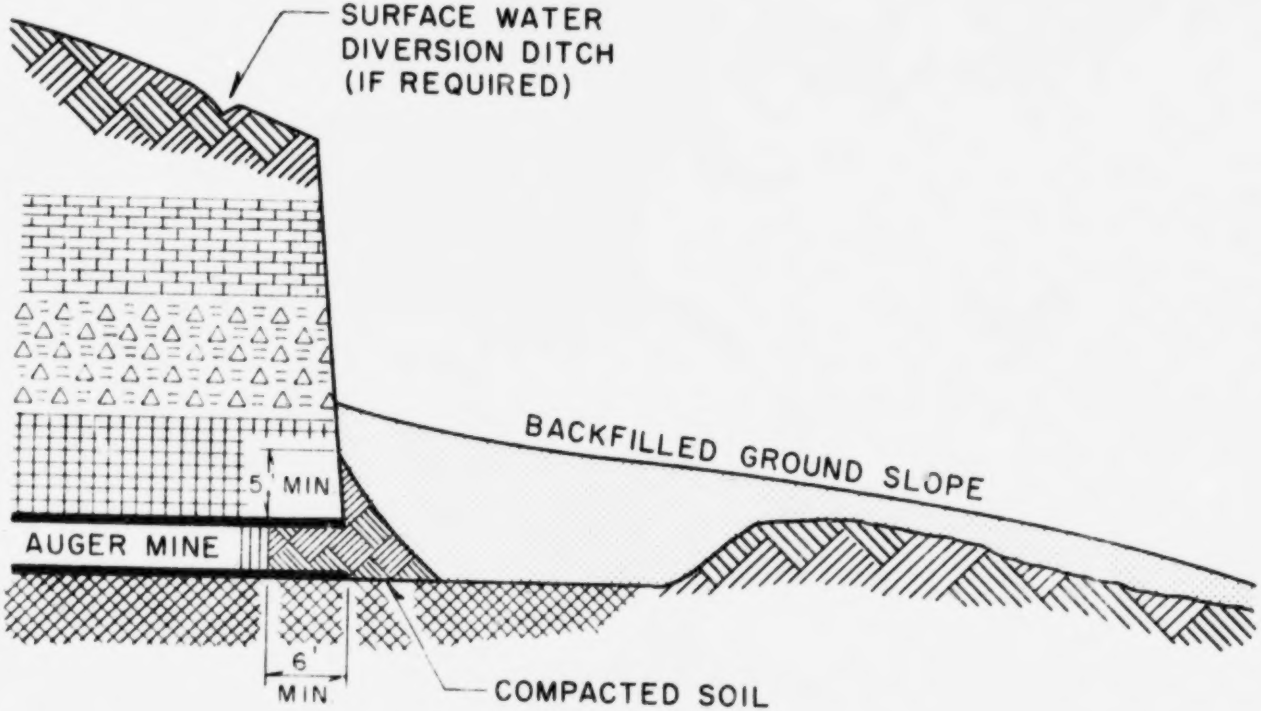
TYPICAL REVERSE TERRACE (II) BACKFILL

FIGURE 18


SURFACE WATER
DIVERSION DITCH
BACKFILLED GROUND SLOPE
5' MIN.
DEEP MINE
6'
MIN.
COMPACTED CLAY SOIL

TYPICAL BACKFILL-DEEP MINE

FIGURE 19


SURFACE WATER
DIVERSION DITCH
(IF REQUIRED)
BACKFILLED GROUND SLOPE
5' MIN
AUGER MINE
6' MIN
COMPACTED SOIL

TYPICAL BACKFILL- AUGER MINE

FIGURE 20

SECTION B - Drift Mine Openings 1, 13 and 14
Priority III (Waynesburg Coal)

Drift mine openings 1 and 13 have fallen in and are overgrown with underbrush. There is a small amount of water seepage immediately in front of these openings. The total seepage from drift mine opening 1 is less than one-half gallon per minute and the total seepage from drift mine opening 13 amounts to two to three gallons per minute. Drift mine opening 14 is still accessible. The present opening is approximately five feet high by eight feet wide. There is a pond of water immediately in front of this opening which is approximately twenty-five feet long by ten feet wide (refer to sample 38, Table 40). Due to the relatively high quality of this discharge water (pH 8.0) and the present condition of these openings, additional work is not recommended for this site.

SECTION B - Drift Mine Openings 4, 5 and 6
Priority III (Waynesburg Coal)

Drift mine openings 4 and 5 are approximately five feet high by eight feet wide. There is a small pond of water at the mouth of each opening. These openings appear to be very shallow (approximately ten feet deep) and have apparently been opened strictly for house coal. There is a small seepage of water immediately in front of these openings. Drift mine opening 6 is approximately five feet high by ten feet wide at the mouth. This opening also has a small amount of water ponded immediately behind the mouth of the mine. It appears to have been developed to a greater extent than drift mine openings 4 and 5; however, it is impossible to tell how extensive the mine really is. There is also a small seepage of water from this drift mine opening. The total seepage from drift mine openings 4, 5 and 6 amounts to less than one gallon per minute. This seepage was sampled on September 20, 1971, (refer to sample 36, Table 38). Due to the relatively high quality of the discharge (pH 7.6) from these openings and the inaccessibility of both openings from any main or secondary highway, reclamation work is not recommended for this site.

SECTION B - Strip Area B
Priority III (Waynesburg Coal)

The total length of this strip area is approximately one thousand feet, the height of the highwall is approximately twenty feet, and the width of the bench is approximately one hundred fifty feet. The height of the outslope averages approximately thirty feet. This strip area has been backfilled with the slope toward the highwall. It is apparently a very old strip, as the area is now covered with a heavy growth of underbrush. This strip area is not visible from any of the major or secondary highways in the area. Surface water drainage would be toward the highwall; however, there is only a slight amount of acidic material present on the bench of this strip area and there are no drift mine or auger mine interceptions within the highwall. Therefore, the pollution problem resulting from this drainage would be minimal. Due to the present condition of this strip area, there would be no significant advantage to performing additional reclamation work at this site.

SECTION B - Strip Area C
Priority III (Waynesburg Coal)

The total length of this strip area is approximately 1500 feet; the height of the highwall is approximately fifty feet, and the width of the bench varies from one hundred fifty to two hundred fifty feet. The outslope is approximately fifty feet high. This strip area has not been backfilled, and there is no vegetative cover on either the outslope or the bench. There is quite a bit of acidic material left on the bench and the outslope. The strip is highly visible from one of the major highways in the area (W. Va. Rt. 46). There are two deep mine interceptions in the northeastern portion of this strip area (mine openings 7 and 8). Recommended reclamation at the site includes compacted earth seals of the mine openings involved, regrading of the spoil banks and the outslope to near original contour, placement of a surface water diversion ditch along the upper portion of the highwall, soil conditioning of the backfill material in order to establish a firm vegetative cover and planting of the area in some species of trees or grass. It should be noted, however, that this strip is presently under active permit and any reclamation work completed at this site should be the responsibility of the permittee.

Mine openings 7 and 8 are deep mine interceptions rather than actual drift mine entries. The entrances of both interceptions are partially covered by material that has fallen from the highwall. Both openings are approximately seven feet high by twelve to fifteen feet wide. Mining in this area would have been to the dip so that surface water would run into the mine rather than drainage running out of the mine. A compacted earth seal should be installed in each of these openings to prevent surface water from entering the mine.

Drift mine opening 10 was apparently abandoned quite some time ago. The opening has fallen in and is overgrown with underbrush. There is no evidence of any water seepage at this time or at any time in the past. Reclamation work is not recommended at this opening.

Drift mine opening 11 was apparently the main opening to a small drift mine. The opening is partially covered by material which has fallen from above the mouth of the mine. The present opening is approximately seven feet high by fifteen feet wide. There is no evidence of any water seepage. Reclamation work is not recommended at this location.

Drift mine opening 12 is almost totally covered by underbrush and debris. There is no evidence of water seepage from the mine. Reclamation work is not recommended at this opening.

SECTION C - Strip Area B
Priority II (Waynesburg Coal)

The total length of this strip area is approximately 2600 feet. The height of the highwall varies from thirty-five to fifty feet and the width of the bench varies from one hundred twenty-five to two hundred feet. This strip mine has not been backfilled and there is a significant amount of acidic material present on both the bench and outslope. There is no vegetation on either the bench or outslope. The height of the outslope is approximately seventy-five feet and the surface condition is very rough. The condition of the highwall varies between very firm in some areas to extremely fractured in other areas, which seems to indicate the presence of drift mine interceptions. There are three ponded areas in this strip mine and each pond averages approximately fifty feet wide by two hundred feet long (refer to sample 20, Table 24). Figure 21 shows a portion of one of the ponded areas in the northern section of the strip pit. There are two large shovels and two other pieces of heavy equipment present at this site. This equipment does not appear to be

[illegible] POND
LOCATION [illegible] AREA [illegible]
FIGURE 21

in operable condition and should be removed. This strip mine is highly visible from one of the secondary roads in the area and may be visible from Interstate 79. Figure 22 shows a portion of the exposed highwall of this strip site as viewed from W. Va. Route 46. There is one drift mine entry in the extreme southern section of this strip (drift mine opening 2). The roof of this entry has collapsed and is overgrown with underbrush. There was no drainage from this entry at the time of inspection and no evidence of any significant drainage at any time in the past. Recommended reclamation at the site includes removal or burial of solid waste and heavy equipment, burial of acidic material present, regrading of spoil banks and outslope to contour or pasture backfill conditions, soil conditioning required to establish a firm vegetative cover and replanting of the area in some species of trees.

SECTION C - Strip Area C
Priority I (Waynesburg Coal)

The total length of this strip area is approximately 2600 feet, the width of the bench varies from one hundred to one hundred fifty feet, and the height of the highwall is approximately fifty feet. The condition of the highwall is very solid, which indicates that there have been no drift mine interceptions in this area. With the exception of approximately 500 feet in the northwestern portion of this strip area, most of the strip has been backfilled with the slope toward the highwall. This area has apparently been planted in grasses which are just beginning to grow. The outslope, however, has no vegetative cover and the condition of this area is very rough. The northwestern section of this strip area has not been backfilled and the base of the highwall has apparently been extensively auger mined. Since the auger mining would have been to the dip in this area, all surface drainage eventually enters these auger mines. Figure 23 shows a portion of this area with associated surface water runoff. This entire strip area will probably be visible from Interstate 79. Reclamation work required at the site should include earth compaction seals in each of the auger mine openings to prevent surface water infiltration, regrading of the spoil bank and outslope in the northwestern portion of the strip to a contour backfill, planting of the area in some species of trees or grasses.

HIGHWALL AND BENCH SHOWING SURFACE WATER RUNOFF
SECTION C, STRIP AREA C
FIGURE 23

SECTION C - Strip Area D
Priority III (Sewickley Coal)

Strip area D has apparently been abandoned for quite some time. The area appears to have been backfilled, although this may also be the result of natural weathering and erosion. The total length of the strip is approximately six hundred feet and the height of the existing highwall is ten to fifteen feet. The strip itself is now covered with a heavy growth of trees and underbrush. There is no evidence of drift mine openings or drift mine interceptions.

Due to the present condition of this strip area, surface water drainage would probably follow natural courses and eventually drain into stream M7-1 (refer to Figure 12). This drainage should not create any significant pollution problems. Due to the natural reclamation of this area and the relative inaccessibility from any major highway, additional reclamation work at this site is not warranted.

SECTION C - Strip Area E
Priority III (Redstone Coal)

This strip area has been almost totally eliminated by the Interstate 79 road construction. The total length of the remaining strip area is approximately two hundred feet, the height of the highwall is approximately fifteen feet, and the width of the bench is approximately fifty feet. The area has been backfilled with the slope toward the highwall and has been planted in pine trees. There is a good growth of both underbrush and pine on the backfilled area. There are no apparent drift mine interceptions or drift mine openings into this strip area. Due to the slope of the backfill, surface water drainage would probably drain toward the highwall and eventually into stream M7-1; however, there is very little acidic material left uncovered in this area and the drainage should not be contaminated. Portions of this strip area will be visible from the new Interstate highway. From an aesthetic point of view, these areas should probably be regraded to an original contour backfill and planted in some type of trees; however, the area does not present any significant drainage problems and the money required to completely reclaim this area could probably be put to better use elsewhere.

SECTION C - Strip Area F
Priority III (Sewickley Coal)

Strip area F appears to be a continuation of strip area G. The height of the existing highwall is approximately twenty feet, the width of the bench is approximately fifty feet, and the total length of this strip area is approximately fifteen hundred feet. The extreme northern section of this strip area has been reclaimed by the Interstate 79 road construction. Natural weathering and erosion have reduced the height of the highwall and spoil banks in the remaining section of the strip to near original contour conditions. The area is now covered with a very dense growth of underbrush and trees. There are four apparent drift mine openings in the extreme northern section of strip area F (drift mine openings 5, 6, 7 and 8). Two of these openings have fallen in and are now covered over. The remaining two entries are still accessible. Since these openings would have been worked to the dip, any surface water drainage would drain into the subsurface water system. This drainage would probably be insignificant in quantity since this strip area is located at the crest of a hill; however, the area is easily accessible and it would be relatively inexpensive to place a clay compaction seal in each of the openings to eliminate surface water infiltration. Due to the present condition of this strip area, it is believed that further reclamation work attempted in this area would be more detrimental than beneficial; however, several areas are presently devoid of vegetative cover and should be revegetated.

SECTION C - Strip Area G
Priority III (Sewickley Coal)

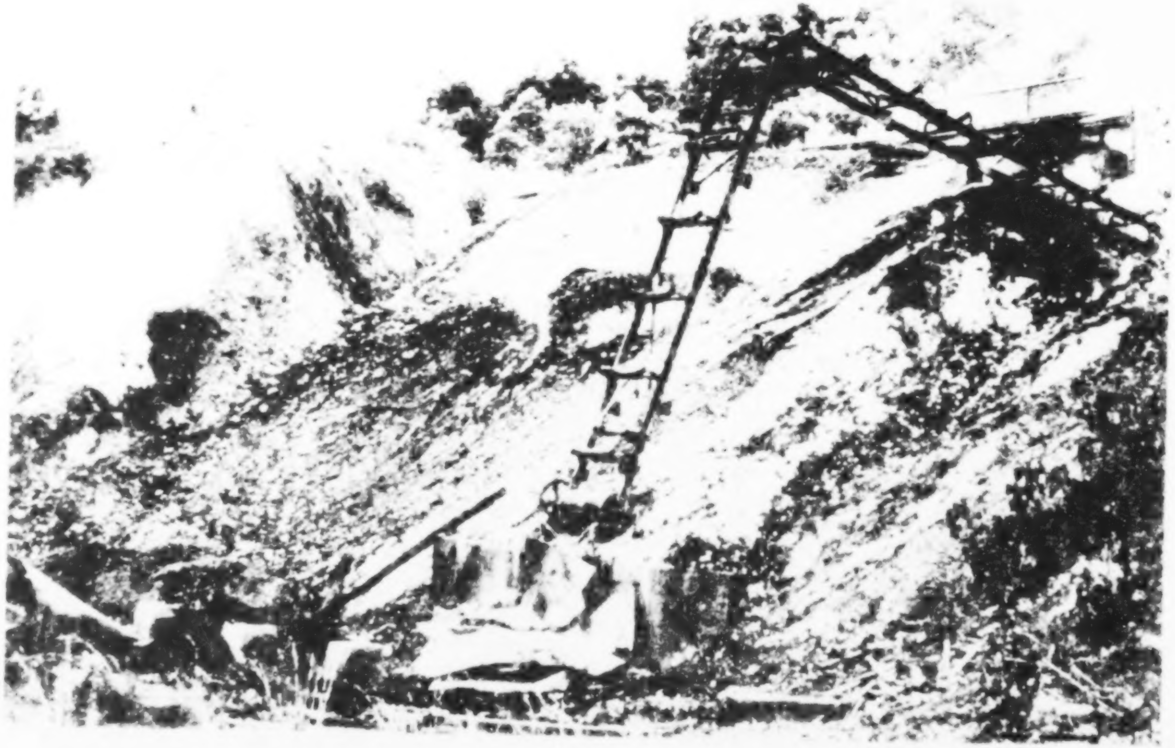
The height of the highwall in this strip area is approximately twenty feet, the width of the bench is approximately fifty feet, and the total length is approximately fifteen hundred feet. This area was apparently worked quite some time ago, and is now overgrown with underbrush and trees. There are several areas along the base of the highwall that appear to have intercepted drift mine workings; however, they have fallen in and are partially overgrown. For the most part, these drift mine interceptions would have been into mines that had been worked to the rise in this area, and therefore any drainage would tend to be from the drift mine workings rather than into them. Drift mine opening 19 is located in the north central section of this strip area. This drift mine opening has fallen in and is now overgrown. There is no evidence of drainage either into or out of any of the drift mine openings or drift mine interceptions located in this strip area. Natural weathering and erosion have reduced the height of the highwall and spoil banks to near original contour conditions. Since the area has now stabilized and is presently covered with a heavy growth of underbrush and trees and there is no significant drainage from this strip area, it is believed that any further reclamation work attempted at this site would be more detrimental than beneficial. There are several areas that have apparently been used as refuse dumps; soil conditioning could be utilized in these areas in order to help establish a firm vegetative cover, providing there are sufficient funds in the project to permit this work.

SECTION C - Strip Area H
Priority II (Sewickley Coal)

The height of the highwall in strip area H varies from fifteen to thirty-five feet, the width of the bench varies from seventy-five to one hundred fifty feet, and the total length of this strip is approximately two thousand feet. Most of this strip area has been backfilled with the slope toward the highwall; however, the southern and western portions of the strip have not been backfilled. There is a heavy growth of black locust on the northern section of the strip which appears to be between five and ten years old. There are three drift mine entries into the highwall of the central and western portions of this strip area (drift mines 11, 12 and 13). All of these entries were apparently worked to the dip and, therefore, drainage should be into the mine rather than out of the mine. Each of the three entries is open and the dimensions of each of the mine openings is approximately five feet high by twelve feet wide. A compacted earth seal should be adequate at each of these entries since mining was to the dip and there is no head of water expected on the seal. There is a pond of water in the western section of the strip pit which is approximately fifty feet long; the water in this pond is highly discolored, indicating the presence of high concentrations of iron. Recommended reclamation work at the site should include placement of a surface water diversion ditch at the base of the highwall in the northern section (there would be no advantage to regrading the entire area since there is a well established growth of trees in this area), installation of earth compaction seals in each of the drift mine openings, treating and draining the ponded water in the western section of the strip, contour backfilling of the remaining portion of the strip and soil conditioning of this portion of the strip in order to establish a firm vegetative cover.

SECTION C - Strip Area J
Priority II (Sewickley Coal)

The height of the highwall in strip area J varies from fifteen to thirty-five feet and the width of the bench averages approximately two hundred feet. The condition of the highwall varies from solid in the eastern portion of the strip to highly fractured in the western portion. The eastern portion of the strip has not been backfilled and the present spoil bank is approximately twenty feet high. The western section of the strip has been backfilled, apparently to aid in the development of the drift mine into the highwall of the strip. There are three drift mine openings in this portion of the strip, drift mine openings 14, 15 and 16. These openings all appear to have been main haulage tunnels. The mouths of drift mine openings 14 and 15 are still open; however, the roof of the haulage tunnel itself appears to have collapsed a short distance behind the mouth of the mine. The roof of drift mine opening 16 has fallen in. Each of these openings could have been worked to either the rise or the dip and it is difficult to estimate the direction of mining without accurate mine maps; however, drift mine opening 14 was apparently worked to the rise, since there is an active discharge from this opening amounting to approximately two gallons per minute. There are several areas along the western portion of the highwall which have apparently been drift mine interceptions and are now collapsed. Due to the extremely fractured condition of the highwall in this area, it is doubtful that any type of water seal would be effective. There is an actively burning refuse dump just north of drift mine opening 15. This dump is approximately fifty feet long by fifty feet wide by thirty feet high (see Figure 24). Recommended reclamation work required at the site includes installation of wet seals at mine openings 14 and 16 (reference Figure 48), installation of a compacted earth seal at mine opening 15, regrading the strip area to a contour backfill, extinguishing the fire in the refuse dump, burial of the material along the base of the highwall and conditioning the backfill material so that the area may be planted in some species of grass or trees.



BURNING REFUSE DUMP
SECTION C, STRIP AREA 1
FIGURE 24

SECTION C - Strip Area K
Priority III (Sewickley Coal)

Strip Area K appears to be quite old and there is a heavy growth of trees and underbrush along the entire length of the strip. The strip extends along the hillside and is approximately twelve to fifteen hundred feet long. Natural weathering and erosion have reduced the height of the highwall and spoil banks to near original contour conditions. There are no apparent openings into deep mine workings at this site. There would be little or no advantage to reworking this area. However, there is one old coal tipple and several junked automobiles in the area which could be removed.

SECTION C - Strip Area L
Priority III (Waynesburg Coal)

This area was stripped at the crest of a hill and there is only a small portion of the highwall remaining. Other sections of the highwall have evidently been removed in order to provide material for the backfill. This strip is seven to eight hundred feet long by approximately two hundred feet wide. The outslope is fifty to seventy feet high. The condition of the outslope is very rough, and there is only sparse vegetative cover on the bench and outslope. Recommended reclamation at the site is limited to soil conditioning and planting of the area in some species of trees.

SECTION C - Mine Dump P

Mine dump P is an active refuse dump and slurry pond of the Christopher Coal Division of the Consolidation Coal Company. The slurry pond area is twelve to fifteen hundred feet long by four hundred fifty feet wide. The area surrounding this pond is presently being used as a refuse dump and is approximately fifteen hundred feet long by three hundred feet wide. There is seepage from the south end of the slurry pond of approximately twenty gallons per minute during the fall of the year (refer to sample 22, Table 26). Consolidation Coal is responsible, under the West Virginia state regulations, for this area and the treatment of any discharge resulting from this operation. This problem will be solved by the completion date of the project. As of this writing, Christopher Coal Division has not submitted plans for the correction of the problem area. Several alternative control methods are being studied.

SECTION C - Mine Dump Q

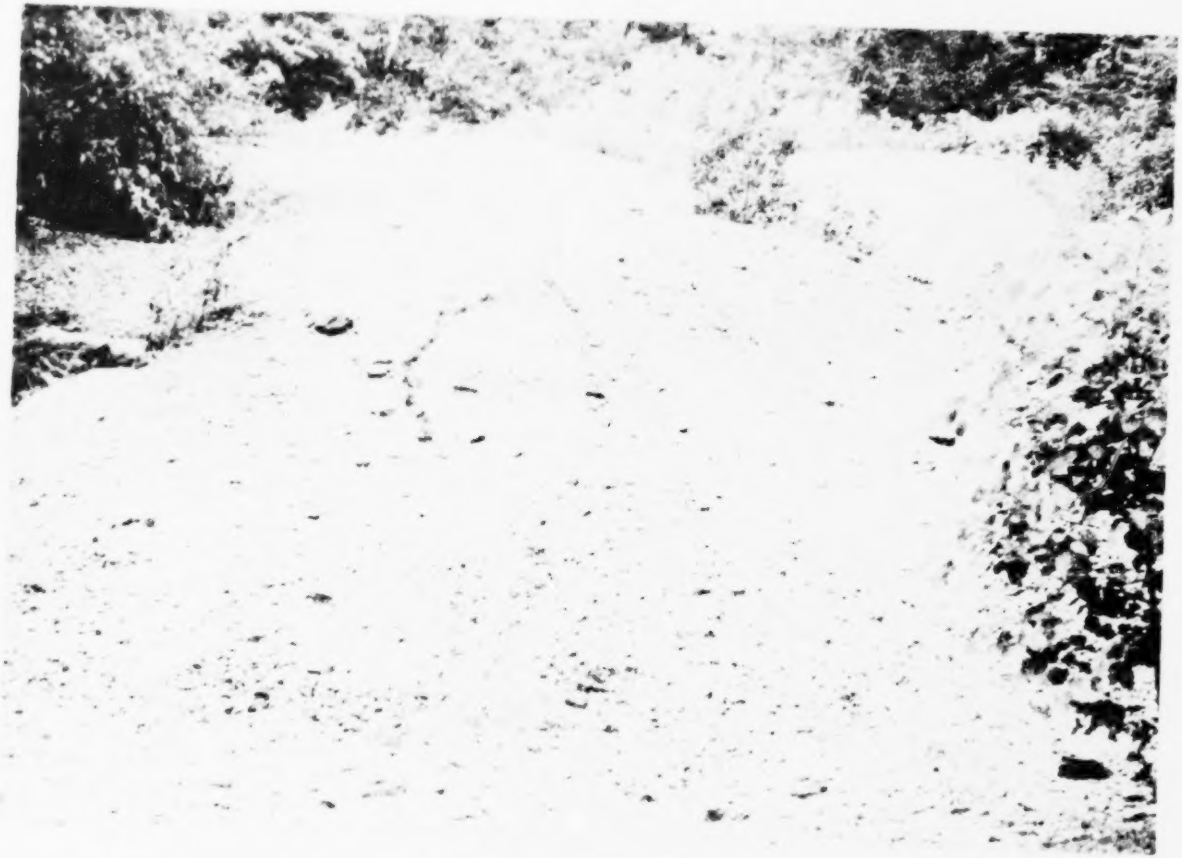
Mine dump Q is an active refuse dump of the Christopher Coal Division of the Consolidation Coal Company. This dump is approximately one thousand feet long by three hundred feet wide and forty to fifty feet deep. There is a continuous discharge from the eastern portion of this dump which averages twenty-five gallons per minute during the fall of the year (refer to sample 19, Table 23). Since this is still an active refuse dump, Christopher Coal is responsible for the elimination or treatment of this discharge under the West Virginia state regulations by July, 1973.

SECTION C - Strip Area S
Priority II (Redstone Coal)

The height of the existing highwall in this strip area is approximately thirty feet, the width of the bench is approximately fifty feet, and the length of the strip area is approximately fifteen hundred feet. This area has not been backfilled; however, the site has apparently stabilized and is now covered with a relatively heavy growth of underbrush and trees. Natural weathering and erosion have reduced the height of the highwall and spoil banks to near original contour conditions. There were no drift mine interceptions or drift mine entries located in this area; however, the presence of several refuse dumps would seem to indicate that there were several drift mine openings in this area at one time (see Figure 25). These openings have apparently fallen in and are now overgrown. These refuse areas should be conditioned with fertilizers and lime in order to establish a firm vegetative cover. Due to the present condition of strip area S, it is believed that any further reclamation attempted at this site would be more detrimental than beneficial.

SECTION C - Strip Area T
Priority III (Waynesburg Coal)

The length of this strip is approximately seven hundred feet, the height of the highwall is generally between thirty-five and forty feet, and the width of the bench varies from fifty to two hundred feet. This is apparently an old strip cut judging from the dense cover of trees and underbrush on the bench and the eroded condition of the



ABANDONED REFUSE DUMP
SECTION C, STRIP AREA S
FIGURE 25

highwall. There are several openings into drift mine workings located along the highwall (drift mine openings 17 and 18). These appear to be interceptions rather than actual drift mine entries. Since the drift mine would have been worked to the dip in this area, surface drainage would flow into the mine rather than out of the mine. This possibly could be eliminated by placing compacted earth seals at each of the openings and placing surface water diversion ditches along the base of the highwall. The outslope to this strip is overgrown with trees and underbrush, and there would be little advantage to regrading this area.

SECTION C - Strip Area U
Priority III (Waynesburg Coal)

The total length of this strip area is approximately one hundred fifty feet and the height of the highwall is twenty-five to thirty feet. The southeastern portion of this strip area was apparently worked quite some time ago, since the area is now eroded and overgrown with underbrush. However, the northeastern portion of this area (approximately sixty feet) is still apparently being used by local residents for house coal supplies. There are no drift mine entries or drift mine interceptions in this area. There is no visible drainage from the area at this time; however, surface water drainage from this area would most likely drain into stream M7-1 (refer to Figure 12). The spoil banks and uncovered acidic material in this area are insignificant due to the relatively small size of the area. Additional reclamation is not recommended at this site.

SECTION C - Drift Mine Openings 9 and 10
Priority III (Sewickley Coal)

Drift mine opening 10 was apparently a main haulage tunnel of a small drift mine. This mine was evidently worked to the rise and, therefore, any drainage within the mine would probably be drained from the mine at this point. The mine has apparently been abandoned for quite some time; the roof of the opening has collapsed and is overgrown with underbrush and some small trees. There was no drainage from this entry at the time of inspection, or evidence of any significant drainage at any time in the past. Reclamation is not recommended for this site.

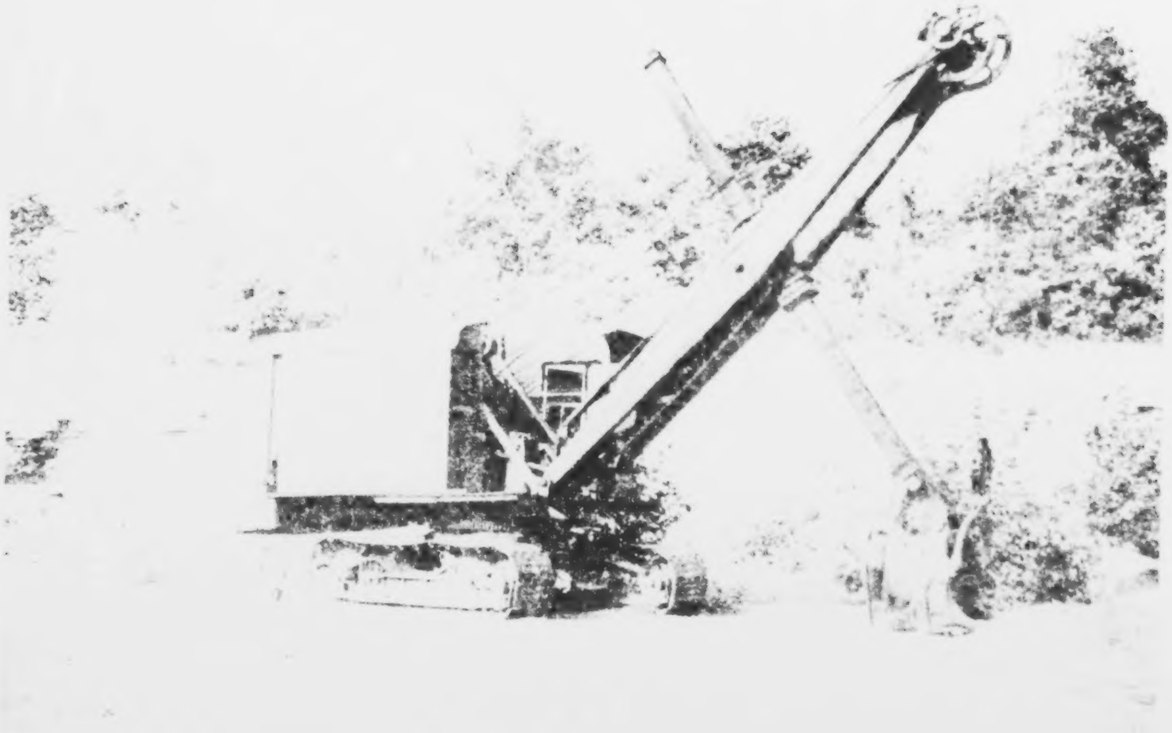
Drift mine opening 9 was apparently the ventilation course for the same small drift mine. The mine is still accessible through the ventilation fan opening at this entry. There is a small pond of water immediately in front of the opening; however, this appears to be surface water drainage rather than drainage from the mine itself. There does not appear to have been any significant drainage from this entry at any time in the past. Reclamation is not recommended for this site.

SECTION F - Strip Area A
Priority II (Waynesburg Coal)

The length of this strip is approximately eighteen hundred feet, the width of the bench is one hundred to one hundred twenty-five feet. The height of the highwall averages approximately thirty feet, and the outslope is approximately fifty feet high. The highwall is relatively solid, and there are very few fractured areas. There are no visible openings into drift mines. The strip is located at the crest of a hill, and the overburden between the coal seam and the surface area is thirty to forty feet. The area has not been backfilled, and there are spoil banks over the entire width of the bench. There is some volunteer growth on the area which appears to be about five years old. This vegetative cover is confined to a very small area of the strip, and the growth in these areas is sparse. The entire area (the bench, the highwall and the outslope) contains considerable acidic material, and there is evidence of drainage and erosion on the outslope. There were no indications of drainage from the area at the time of inspection. At present, there are two abandoned shovels and one tractor trailer on the strip (see Figure 26). These should be removed, as it is doubtful that they can be moved under their own power. Recommended reclamation at the site includes removal of all solid wastes, contour backfilling of the entire strip area, soil conditioning of the backfill and planting of the area in some species of trees or grasses.

SECTION F - Strip Area B
Priority III (Waynesburg Coal)

The height of the highwall is twenty to twenty-five feet, the width of the bench varies from one hundred to three hundred feet, and the outslope is fifteen to twenty feet high. The total length of the strip mine is approximately six hundred feet. This strip is located about one-tenth



ABANDONED COAL EQUIPMENT
SECTION F, STRIP AREA A
FIGURE 26

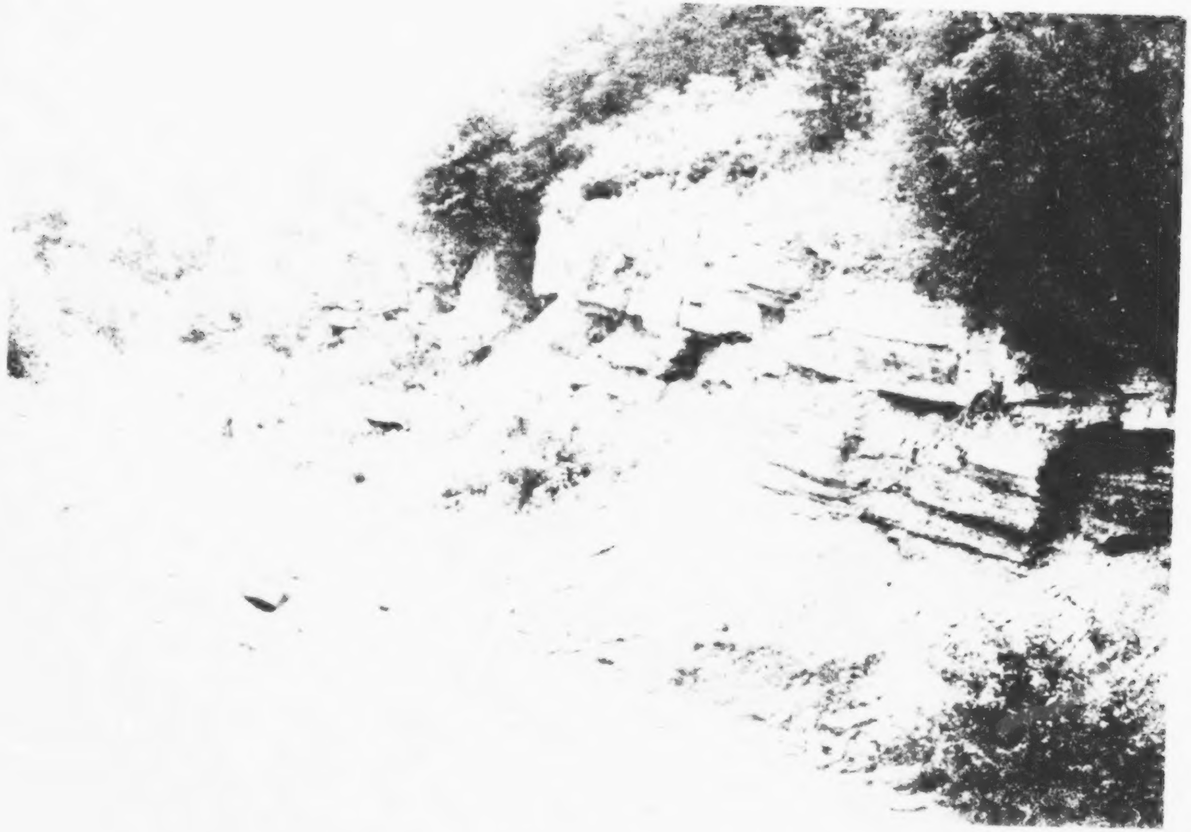
of a mile south of U.S. Route 19, but it is not highly visible from the road due to the vegetative growth in the area. The condition of the highwall is relatively stable, which indicates the absence of drift mine entries or interceptions. The area has been backfilled with the slope toward the highwall (see Figure 27). There are areas where there have been visible runoffs toward the highwall, but there was no apparent seepage from the area. There is a growth of black locusts on the backfill which appears to be several years old and the area has also been planted in pines which are presently one to two feet high. Recommended reclamation at the site includes soil conditioning and supplemental planting of the area in some species of trees or grasses.

SECTION F - Strip Area C
Priority III (Waynesburg Coal)

There are apparently two benches at this strip site. The height of the highwall varies from twenty-five to seventy-five feet, the width of the bench is approximately three hundred feet and the total length of this strip is approximately three thousand feet. This strip has been backfilled with a contour backfill, and the backfilled area has recently been planted in grasses. The highwall appears very solid, indicating the absence of drift mine entries or interceptions. There appears to be some acidic material on the backfill, but it does not appear to be affecting the growth of the grasses. This is an exceptionally good backfill; however, from a purely aesthetic point of view, the highwall should be lowered. The outslope of the strip mine is approximately seventy-five feet high. Portions of this strip area have been planted in grasses and the remainder has apparently been prepared for planting. Recommended reclamation at the site includes regrading the outslope, soil conditioning and seeding of unplanted areas in some species of trees.

SECTION F - Drift Mine Openings 1, 2, 3 and 4
Priority III (Waynesburg Coal)

Drift mine opening 1 has apparently fallen in and is now sealed. It is one opening of a group of four. This drift mine appears to have been abandoned quite some time ago, as indicated by the appearance of the entries and the mine tracks in the area. Drift mine opening 2 is still accessible and is approximately ten feet wide by



TYPICAL REVERSE TERRACE BACKFILL
SECTION F, STRIP AREA B
FIGURE 27

seven feet high. There is a small amount of seepage from this entry, totaling approximately one-half gallon per minute. The water was sampled in August, 1971, (refer to sample 30, Table 34). The pH at that time was 6.8, alkalinity exceeded acidity, and total iron was 2.2 ppm. Drift mine opening 3 has partially fallen in. Part of the coal seam is still exposed. There is water ponded in the entry; however, there does not appear to be any seepage from the opening. Drift mine opening 4 is apparently part of the same small drift mine. The entry has fallen in and is now overgrown. There is no apparent seepage from the entry and no signs of seepage at any time in the past. There is a small spoil bank approximately twenty feet wide by twenty feet long and five feet high which is not visible from the road.

The mines are located just north of an infrequently traveled dirt road. There are only meager signs that the mines ever existed in this area (a small refuse dump exists alongside the road). Due to the relatively high quality of the water discharged from these mines and their inaccessibility, reclamation is not recommended at this site.

SECTION G - Strip Area A
Priority I (Waynesburg Coal)

The exposed highwall of strip area A averages thirty feet, the width of the bench is approximately one hundred twenty-five feet and the height of the outslope is approximately forty feet. The total length of this strip is approximately fifteen hundred feet. The condition of the highwall is generally very solid. There is one section near the southeast portion of the strip which is highly fractured; the fracture zone runs at a forty-five degree angle to the highwall and extends back approximately fifty feet. There is also some local subsidence in the area. The fracture zone and subsidence area would require some type of grout or clay compaction seal in order to reduce surface water infiltration. The strip area has been backfilled and the bench dips slightly toward the highwall; however, there is no vegetative cover on either the bench or the outslope. There are several areas along the highwall in which there are exposed auger holes. Only four auger holes are now open in the area since the strip has been backfilled; however, it is probable that augering has been completed along the entire length of the strip. The surface drainage courses in this area direct all surface water into the auger openings. Recommended reclamation at the site includes sealing of the fractured area, placement of a surface water diversion ditch above this area, compaction sealing of the auger areas, regrading of the bench and outslope to Pasture backfill, soil conditioning and establishment of a good vegetative cover in the area.

SECTION G - Strip Area B
Priority II (Sewickley Coal)

Strip area B is located approximately seventy-five feet below and parallel to strip area A. Strip area B was evidently worked quite some time ago, judging by the appearance of the spoil banks and the vegetative cover in the area. The area has not been backfilled; however, natural weathering and erosion have reduced the height of the highwall and spoil banks to near original contour conditions. The width of the bench of this strip varies from fifty to four hundred fifty feet, and the total length is approximately two thousand feet. There appears to be a considerable amount of acidic material exposed on the spoil banks and outslope; however, any attempts to regrade or otherwise disturb this area would probably be more detrimental than advantageous. Recommended reclamation at the site includes conditioning of the spoil banks, and supplemental planting of some species of trees.

SECTION G - Strip Area C
Priority II (Sewickley Coal)

The height of the existing highwall in strip area C is twenty to twenty-five feet, the width of the bench varies from fifty to three hundred feet, and the height of the outslope is twenty to thirty feet. The total length of the strip is approximately fifteen hundred feet. The area has been backfilled with a slight dip of the backfill toward the highwall. The condition of the outslope is fairly smooth; however, there is no vegetative cover on the outslope or the bench (see Figure 28). There are no visible drift mine openings or interceptions in the area. There is evidence of surface runoff and, judging from the iron stains on the bottom of the stream bed, the drainage is acidic in nature. The location of the strip represents the headwaters of stream M7-3. The total drainage from all of the

REGRADED BENCH AREA SHOWING LACK OF VEGETATION
SECTION G, STRIP AREA C
FIGURE 28

surface runoff from any of the strip mines in the area, is eventually drained into M7-3. This stream has been sampled on several occasions (refer to sample 24, Table 28). Recommended reclamation at this site includes soil conditioning (neutralization and fertilization) and planting of some species of trees or grasses.

SECTION G - Strip Area D
Priority II (Waynesburg Coal)

The highwall in strip area D varies from twenty to fifty feet, the width of the bench is approximately seventy-five feet and the outslope is twenty to twenty-five feet high. The extreme southeastern section, the portion in which drift mine opening 31 is located, has recently been backfilled and planted in grasses. The existing highwall in this section is approximately forty feet high. This is generally a very good backfill; however, nothing has been done to the outslope, and the slope of the backfill itself is slightly toward the highwall. The remaining section of strip area D, from drift mine opening 30 to the extreme northern section of this strip, has not been backfilled. The height of the spoil banks in this section varies from twenty-five to forty-five feet. There is considerable acidic material along the bench and on the spoil banks of the strip, and very little vegetative cover exists over most of the area.

Drift mine opening 29 was apparently the main haulage tunnel for what appears to have been a large drift mine. The original opening has partially fallen in, and the existing opening is approximately four feet high by fifteen feet wide. This opening, as well as all other openings which are found in this strip area, has been mined to the rise so that any drainage would be from the mine rather than into the mine. At present, there is no drainage from this particular opening; however, there is evidence immediately in front of the opening that there has been drainage at times. The drainage course is highly stained, indicating the presence of high concentrations of iron. Drift mine opening 30 was apparently an alternate haulage route. The dimensions of this opening are similar to those of drift mine opening 29. There are no signs of drainage from the opening either now or in the past. Drift mine opening 28 was apparently a ventilation tunnel. The present opening is approximately four feet in diameter. There are no signs of drainage from the entry, either now or in the past. Drift mine opening 27 appears to have been a drift mine interception into one of the main haulage tunnels. The present opening is quite large, approximately five feet high by twenty to twenty-five feet wide. There is a large pond of water immediately behind the material which has fallen from the highwall in front of this opening. There are also signs of seepage immediately in front of the opening. Drift mine openings 25 and 26 are very similar in appearance to drift mine opening 27. However, they have partially fallen in and it is not known whether water is ponded behind each of these falls. Drift mine openings 23 and 24 are also drift mine interceptions; however, they have fallen in and are now covered over. There is evidence along the base of the highwall of the strip area that water has drained from each of the openings at one time or another; however, the drainage appears to have been small in quantity. As reclamation work is completed at strip area A, Section G, infiltration into the deep mine workings should be decreased with a consequent reduction in the drainage from strip area D.

Recommended reclamation at the site includes installation of a wet seal at mine opening 29, installation of compacted earth seals at the remaining mine openings, complete pasture backfilling, conditioning of the backfill in order to permit the establishment of a firm vegetative growth and planting of the area in some species of grasses or trees.

SECTION G - Strip Area E
Priority III (Sewickley Coal)

Strip area E is located below and parallel to strip area D. The strip was evidently worked quite some time ago and is now overgrown with a heavy stand of trees and underbrush. The strip mine was not backfilled and there are several areas which still contain excessive amounts of acidic material. However, any disturbance to these areas would probably be more detrimental than beneficial. Natural weathering and erosion have reduced the height of the highwalls and spoil banks to near original contour conditions. There is evidence of two drift mine openings in the southern portion of this strip (drift mine openings 60 and 61). These entries have caved in and are overgrown; however, there is a small amount of seepage in front of each of the entries. The seepage amounts to less than one-half gallon per minute. Due to the present condition of this strip area the only reclamation recommended at this site would be soil conditioning and revegetation of those areas which are presently devoid of vegetative cover.

SECTION G - Strip Area F
Priority III (Waynesburg Coal)

The highwall in strip area F is thirty-five to forty feet high, the width of the bench is approximately one hundred twenty-five feet and the height of the outslope is thirty-five to forty feet. The total length of this strip is approximately six hundred feet. The highwall is relatively solid, which indicates the absence of drift mine interceptions. Most of the area has been backfilled with the slope toward the highwall; approximately thirty yards in the extreme northern section of this strip has not been backfilled. There are some grasses and light underbrush growing on the backfilled area, along with several small trees. The strip is highly visible from U.S. Route 19. Recommended reclamation at the site includes soil conditioning of the bench and outslope and planting of the area in some species of trees.

SECTION G - Strip Area G
Priority II (Sewickley Coal)

The total length of the strip area is approximately twelve hundred feet, the height of the highwall varies from thirty to forty-five feet and the width of the bench averages about fifty feet. The highwall is highly fractured, and there are numerous drift mine interceptions along the entire length of the strip cut. The area has not been backfilled and there is considerable acidic material on both the bench and spoil banks. There is very little vegetative cover on either the bench or the outslope. The strip area is not visible from any major or secondary highway in the area. There are approximately ten drift mine entries or drift mine interceptions into the drift mine workings located along the highwall of the strip area.

Drift mine opening 13 is located at the extreme northern end of strip area G. The opening has fallen in and there are several areas of stagnant ponded water in front of the opening. Minimal drainage from this area combines with the drainage from drift mine opening 14. There is also an extensive area of subsidence between drift mine openings 13 and 14.

Drift opening 14 appears to be a drift mine interception rather than an actual drift mine entry. The present opening is approximately six feet high by twelve feet wide. Some water is ponded behind the material which has fallen from the highwall immediately in front of the opening, which has resulted in a small amount of drainage seeping through the material. The drainage amounts to five to seven gallons per minute, which combines with other drainage from the highwall of the strip area and finally discharges into stream M7-4 at the rate of seven to eight gallons per minute.

Drift mine opening 15 was also apparently a ventilation shaft. The present opening is approximately six feet high by seventeen feet wide. There is some drainage from the opening, which combines with the drainage from drift mine opening 16 and flows into stream M7-4 at the rate of five to seven gallons per minute.

Drift mine opening 16 was apparently a main haulage tunnel. The present opening is approximately six feet high by twelve feet wide. There is an extensive subsidence area above the opening. At the present time, there is a drainage from the mine opening amounting to approximately three gallons per minute.

Drift mine opening 17 was apparently a ventilation tunnel. The opening has fallen in and there is drainage of two to three gallons per minute from the site.

Drift mine opening 18 was apparently a main haulage tunnel. The present opening is approximately five feet high by twelve feet wide (see Figure 29). There is drainage from the entry amounting to five to seven gallons per minute. The drainage combines with surface water drainage from the southern half of the strip area and drains into stream M7-4 at a current rate of thirty to thirty-five gallons per minute.

Drift mine opening 19 appears to have been a drift mine interception at the junction of two haulage tunnels. The present opening is approximately five feet high by twelve feet wide. There was no sign of drainage from this entry at the time of inspection. There is a very large subsidence immediately over the mine opening.

Drift mine opening 20 was apparently used as a secondary haulage tunnel. The opening is partially covered by material which has fallen from the highwall of the strip cut. The present opening is approximately four feet high by ten feet wide. There is no evidence of water behind the partial seal and no supporting evidence of drainage at any time in the past from the opening.

Drift mine opening 21 is approximately twenty-five feet north of drift mine opening 22. It was also apparently a main haulage tunnel. The present opening is approximately four feet high by twelve feet wide. The mouth of the opening is partially covered by material that has fallen from the highwall. There is no water behind the seal and no evidence of drainage from the entry.

Drift mine opening 22 was apparently one of the main haulage tunnels for the drift mine. The present opening is approximately four feet high by six feet wide. There is no apparent drainage from the drift mine opening at this time and no evidence of any significant drainage in the past.

There are also several other areas that apparently have intercepted drift mine workings; however, they have fallen in and are not accessible from the highwall. Drift mine workings along the highwall were apparently worked to the rise; therefore, any drainage would flow out of the mine rather than into the mine. At the present time, there is drainage from six of the drift mine entries; however, it appears to be surface water runoff from the highwall. Recommended reclamation at the site includes burial of all acidic material present, sealing of mine openings 16 and 18 with a wet seal, sealing each of the remaining drift mine entries or interceptions with a compacted earth seal, complete pasture backfilling of the strip area, sealing of subsidence areas, placement of a surface water diversion ditch along the upper portion of the highwall, soil conditioning of the backfill material in order to establish a firm vegetative cover and replanting of the area in some species of trees and grasses.

The drainages mentioned above represent a period following several days of moderately heavy rainfall. The normal discharge from the mine openings amounts to five to seven gallons per minute. Due to the extensively fractured condition of the highwall and the strip area, it is doubtful that any type of a hydraulic seal would prevent future drainage from this area. In view of this condition, the money required to install hydraulic seals could not be justified. It should also be noted that the majority of the drainage from the area apparently comes from surface water runoff from the highwall rather than from the mine itself. The installation of a surface water diversion ditch along the upper portion of the highwall would reduce the volume of this drainage to insignificant levels.

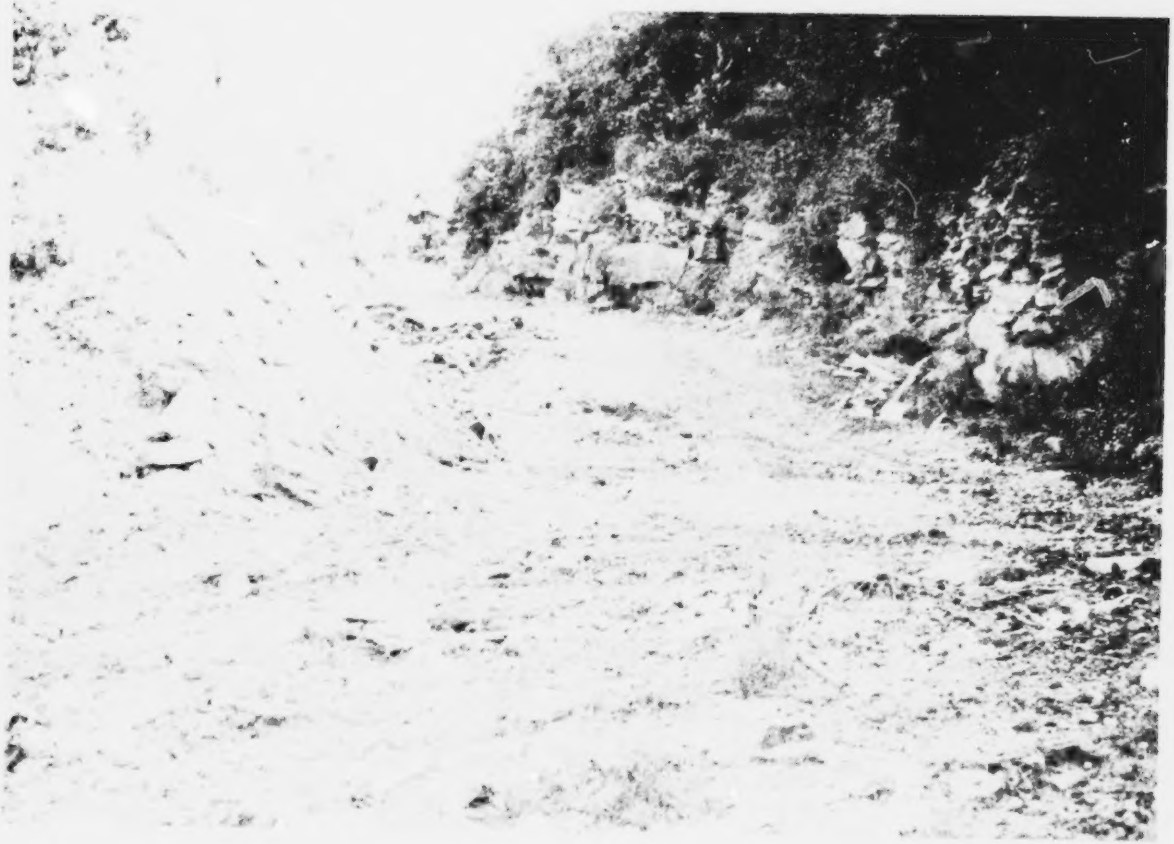
SECTION G - Strip Area H
Priority III (Sewickley Coal)

The height of the highwall in this strip is approximately forty feet, the width of the bench is fifty to seventy-five feet and the spoil banks are approximately twenty-five feet high. The total length of the strip area is approximately six hundred feet. The strip has not been backfilled; however, there is a moderate cover of trees on both the spoil bank and the bench. The trees appear to be at least fifteen years old.

There are three drift mine openings in this strip cut, all of which are open. These mines were worked to the rise; however, there was no drainage from any of the openings at the time of inspection. There are signs that there has been drainage from both drift mine openings 11 and 12. This probably would have occurred during periods of relatively high water. The present dimensions of each of these openings are approximately six feet high by twelve feet wide. Recommended reclamation at the site includes sealing of the three drift mine entries involved with a compacted earthen seal, contour backfilling, soil conditioning of the backfill and planting of the area in some species of trees and grasses.

SECTION G - Strip Area J
Priority I (Sewickley Coal)

This area is presently being used as a sanitary landfill for the towns of Westover and Granville (see Figure 30). The sanitary landfill operator has stated that the expected life of the strip area as a landfill operation is between four and five years; however, recent public



SANITARY LANDFILL
SECTION G, STRIP AREA J
FIGURE 30

opposition to this site for future landfill usage has resulted in an injunction against the operator and it is doubtful that the area will be reopened.

The total length of strip area J is approximately one thousand feet. The width of the bench varies from seventy-five to two hundred feet. The height of the exposed highwall area varies from approximately twenty feet in the areas which have already been landfilled to approximately forty-five feet in areas which have not yet been landfilled.

There are approximately nine drift mine interceptions in the northern section along the highwall of the strip mine area. Since mining would have been to the dip in the area, it is suspected that any surface water falling on the strip cut or landfill operation would eventually drain into the drift mine interceptions. Several areas of extensive surface subsidence and fracturing have been located at the top of the highwall. These areas intercept a relatively large drainage area and would effectively drain any surface water into the abandoned deep mine workings.

Recommended reclamation at the site includes placement of a surface water diversion ditch along the top of the highwall, grouting or sealing of the fracture and subsidence areas near the top of the highwall, compacted contour/pasture backfill and planting of the area in trees and grasses.

SECTION G - Strip Area K
Priority III (Sewickley Coal)

Strip area K has also been used as a sanitary landfill. The landfill has been completed and the area is now being used as a junkyard. The remaining exposed highwall area is ten to fifteen feet high. The highwall is highly fractured, and there are numerous drift mine interceptions still exposed in the area. Drift mining in the area would have been to the rise and, therefore, any drainage associated with the mining operation would drain from the mines rather than into the mines. There are no signs of drainage from any of the interceptions in this area. However, since the area has been used as a sanitary landfill operation, it is suspected that any drainage would percolate through the landfill and would not be appreciably noticeable in the area of the highwall. The outer perimeter of the landfill operation was checked for drainage. There was no visible drainage at the time and no signs of excessive drainage at any time in the past. The cover over the old landfill operation is minimal and should be increased to at least six inches in order to prevent surface water infiltration. While the area is a definite eyesore, it is not noticeable from any of the major highways in the area, despite the fact that it is immediately adjacent to U.S. Route 19. Since this area is not of major concern from a pollution viewpoint, reclamation is not recommended at this site.

SECTION G - Strip Area L
Priority III (Sewickley Coal)

The height of the highwall in this strip varies from twenty to forty feet, the width of the bench is approximately thirty feet and the total length of this entire section is only six hundred feet. The highwall is highly fractured, which is apparently the result of numerous drift mine interceptions in the eastern section. There is some vegetative cover in this area; however, the majority of the bench and the outslope is still barren. The strip mine is located immediately adjacent to U.S. Route 19, and it is generally visible from the highway. There are several drift mine openings on the strip and immediately adjacent to the strip which could be sealed. Each opening will be discussed on an individual basis.

Drift mine openings 32 and 33 have apparently been abandoned for quite some time and are now fallen in and overgrown. There is no visible seepage from either of the areas; therefore, reclamation work is not required at either of the entries.

Drift mine opening 34 was apparently a main entry into this small drift mine. The opening is approximately six feet high by fifteen feet wide. There is no evidence of drainage either into or out of the mine opening.

Drift mine opening 35 was apparently a main haulage tunnel. The mine was worked to the rise so that drainage would flow from the mine rather than into it. There were no signs of drainage from the mine, either now or in the past.

Mine opening 36 is apparently a deep mine interception rather than a drift mine opening. The opening has caved in and is now completely closed.

Mine opening 37 also appears to be a deep mine interception rather than an actual drift mine entry. The roof of this opening has collapsed. There appear to be three or four additional interceptions in this area; however, the highwall is so fractured and fallen that it is difficult to tell whether they are actual interceptions or merely areas where the fractured highwall has fallen in. The only reclamation recommended at this site would be the placement of a surface water diversion ditch along the top of the highwall in order to divert surface runoff away from the fractured highwall of this strip.

SECTION G - Strip Area M
Priority II (Sewickley Coal)

The height of the highwall is approximately twenty feet, the width of the bench is one hundred to one hundred twenty-five feet and the height of the outslope is twenty to twenty-five feet. The highwall is highly fractured, indicating the presence of deep mine interceptions or entries. The total length of the strip is approximately six hundred feet. The eastern half of the strip area has been backfilled; however, a relatively poor job has been done and the area should be regraded. The western section has not been backfilled. There is some growth on the eastern section of the strip, primarily pine. The western section is devoid of vegetative cover. Some material has fallen at the base of the highwall, concealing openings into the drift mines which may be located in the area. There is one opening in the central section of the strip (drift mine opening 38). There is no discharge from this opening during the dry season; however, during the winter and spring seasons there is an almost continuous discharge which has been measured as high as 400-500 gpm. There are several areas that appear to have cut into the drift mine; however, they are now hidden by the material that has fallen from the highwall (drift mine opening 39). The strip is highly visible from U.S. Route 19. Recommended reclamation at the site includes installation of a wet seal at mine opening 38 and a compacted earth seal at mine opening 39, regrading of the bench and outslope to a more natural contour, soil conditioning of the backfill and planting of trees and grasses.

SECTION G - Mine Dump N
Priority II

This refuse dump is approximately four hundred feet long, sixty feet high and varies from fifty to one hundred feet wide. This area is visible from U.S. Route 19. The dump and the area below is completely devoid of vegetative cover and there is evidence of pollution from seepage water of the dump. At several points the toe of the pile encroaches on the stream channel. Recommended reclamation at this site includes removal of all refuse in or near the stream (10 foot minimum), reshaping of the dump to a more natural contour, rerouting of surface water drainways, treatment of the refuse with fly ash and fertilizers and planting the area with grasses.

SECTION G - Strip Area P
Priority II (Sewickley Coal)

Strip area P is located immediately below and parallel to strip area Q. Much of the area has been covered by the outslope from strip area Q. In the areas where strip area P has not been covered by the strip area Q outslope, the highwall is twenty to twenty-five feet high. The exposed highwall appears to be very solid and is evidently not extensively undermined. The area does not appear to have been backfilled; however, it is apparently a very old strip and is presently overgrown with trees and underbrush. While this area is generally visible from U.S. Route 19, the vegetative cover hides most of the strip mine scars. The most readily apparent scar in the area is the outslope from strip area Q. There are several points of seepage from strip area P. The total seepage from this area at the time of inspection amounted to approximately five gallons per minute. Recommended reclamation at the site should include regrading of the outslope of strip area Q to cover most of the exposed sections of the strip area. Little advantage would be gained by regrading the bench of the strip, which is presently under very heavy vegetative cover.

SECTION G - Strip Area Q
Priority II (Waynesburg Coal)

The height of the highwall in this strip is forty to fifty feet, the width of the bench is approximately one hundred twenty-five feet and the outslope is approximately seventy-five feet high. The condition of the outslope is very rough as is illustrated in Figure 31. The length of this strip is approximately one mile. There are twenty to twenty-five junked automobiles on the southeastern section of the strip, along with a small amount of other solid wastes. There are eight drift mine openings on the extreme western section of the strip, two of which have active discharges (refer to sample 18, Table 22, and sample 33, Table 36). The entire strip is highly visible from U.S. Route 19. Portions of the highwall are highly fractured, presumably caused by the interception of drift mines (see Figure 32). The strip has been backfilled with the slope of the backfill toward the highwall; however, there are only small areas where vegetative cover exists on either the bench or the outslope.

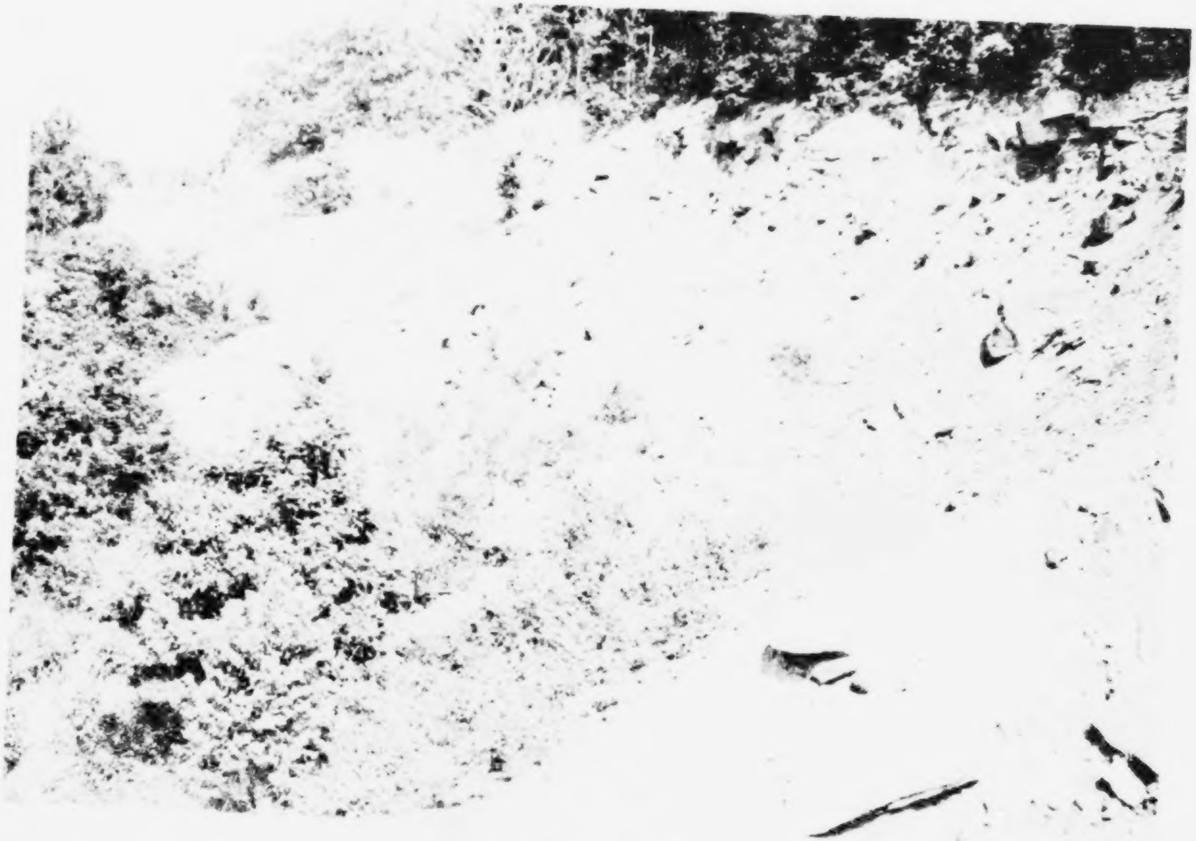
Mine opening 48 appears to be a drift mine interception rather than an actual drift mine entry. The opening is approximately four and one-half feet high by twelve feet wide. There are no signs of water entering or leaving this opening.

Drift mine openings 49 and 50 show no sign of water flow into or out of these mine openings. Mine opening 50 was apparently a ventilation shaft. The opening is approximately four and one-half feet high by six feet wide.

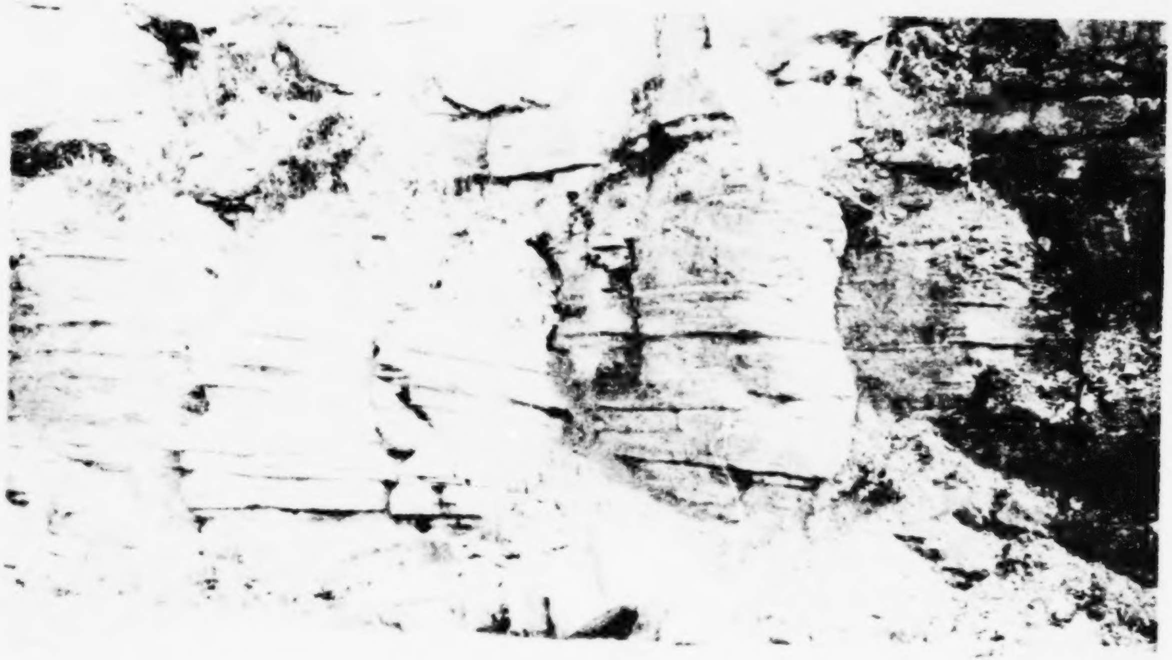
Drift mine openings 49, 50 and 51 appear to be a part of a small drift mine which is separate from drift mine openings 52, 53, 54 and 55. The mine was developed to the dip and, therefore, any water flow would be into the mine. Drift mine opening 51 was apparently a main haulage route of this small drift mine. This opening is approximately ten feet high by nine feet wide. The overburden immediately above the entry is highly fractured.

Drift mine opening 52 appears to have been a main haulage route, probably for the same mine as openings 53, 54 and 55. There is a large pond of water immediately in front of the opening, which apparently originates within the mine. The pond has an active drainage of two to three gallons per minute. The discharge was sampled on August 31, 1971 (refer to sample 33, Table 36).

Mine opening 53 was apparently a main haulage route. It has partially fallen in and the present opening is approximately twelve feet wide by four feet high (see



TYPICAL CONDITION OF "REGRADED" OUTSLOPE
SECTION G, STRIP AREA Q
FIGURE 31



FRACTURED HIGHWALL
SECTION G, STRIP AREA Q
FIGURE 32

Figure 33). There is drainage from this opening amounting to approximately two gallons per minute (refer to sample 18, Table 22).

Mine opening 54 was apparently an alternate haulage route. It is now partially sealed with a concrete block seal; however, there is an opening through the seal approximately three feet in diameter. There is a small amount of water ponded behind the seal, which presently seeps through and joins the drainage from mine openings 55 and 53.

Mine opening 55 was a ventilation shaft into what appears to have been an extensive drift mine. The opening is approximately four feet in diameter, and there is a small amount of water ponded in the opening. Material has fallen from the highwall, partially covering the opening. There is seepage through the material from the drift mine amounting to approximately one-half gallon per minute at the time of this investigation.

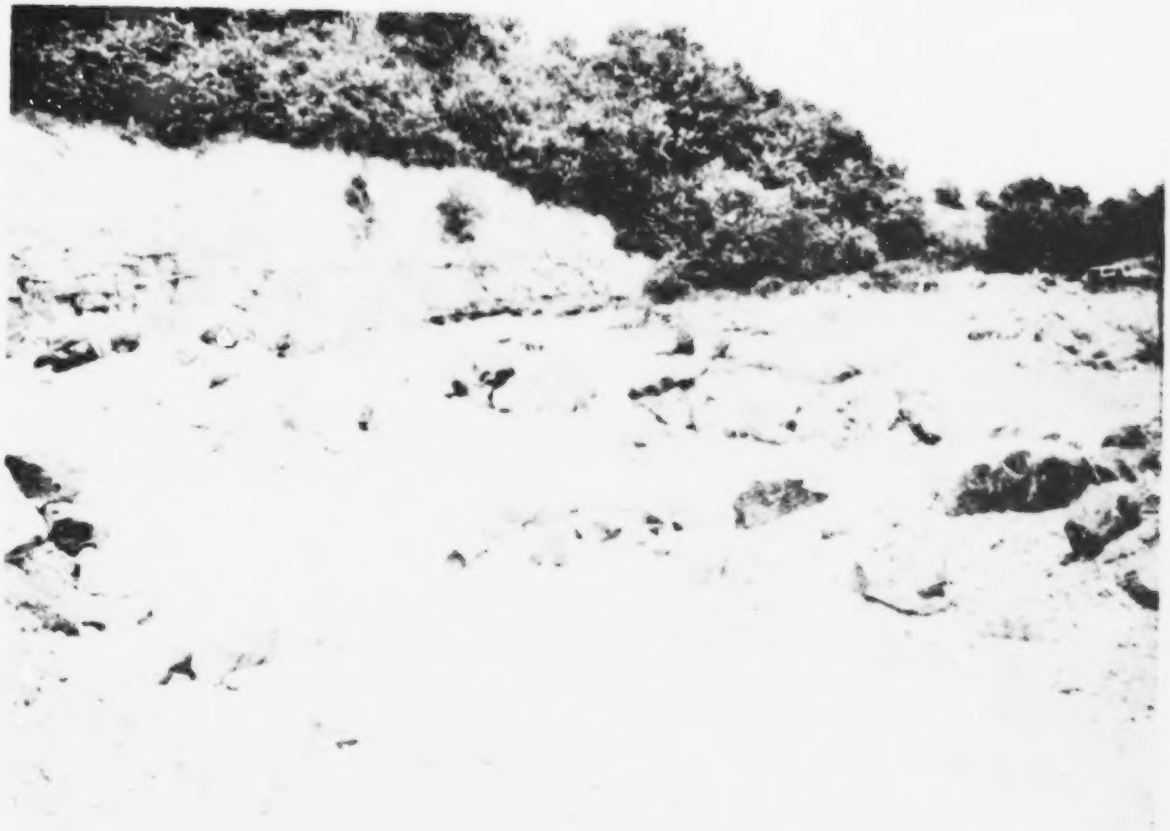
Reclamation at the site should include installation of wet seals at mine openings 52 and 53, installation of compacted earth seals at all remaining mine openings, regrading to a pasture backfill, removal of tipple, tracks, junk vehicles and trash, soil conditioning of the spoil and planting the area in trees and grasses.

SECTION G - Strip Area R
Priority I (Waynesburg Coal)

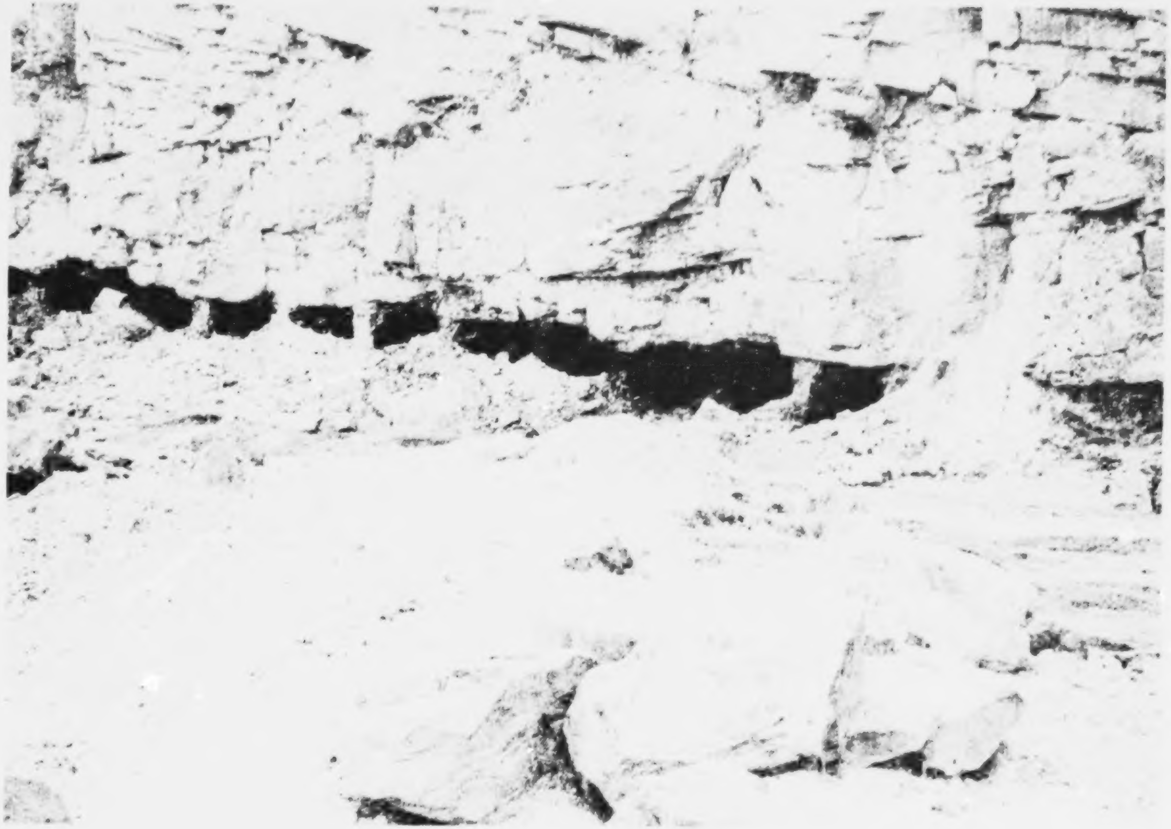
This strip area can be divided into two sections, an east and a west section. Each section is described separately:

East Section

The highwall in the east section is forty to fifty feet high, the width of the bench is approximately two hundred fifty feet and the outslope is forty to fifty feet high. The strip mine has not been backfilled, and there is no vegetative cover on either the bench or the outslope in this area (see Figure 34). There is considerable solid waste in the area which could probably be buried in the highwall when the strip area is backfilled. The highwall is highly fractured in certain areas due to extensive auger mining. There are twenty visible auger openings (see Figure 35). It is estimated that there may be as



TYPICAL CONDITION OF BENCH AND HIGHWALL
SECTION G, STRIP AREA R
FIGURE 34



TYPICAL AUGER OPENINGS
SECTION G, STRIP AREA R
FIGURE 35

many as sixty additional openings; however, material has fallen from the highwall and partially covered most of these, making it impossible to determine the extent of auger mining in the area. There is evidence of water infiltration into the auger openings; however, no active drainage was observed at the time of this investigation.

West Section

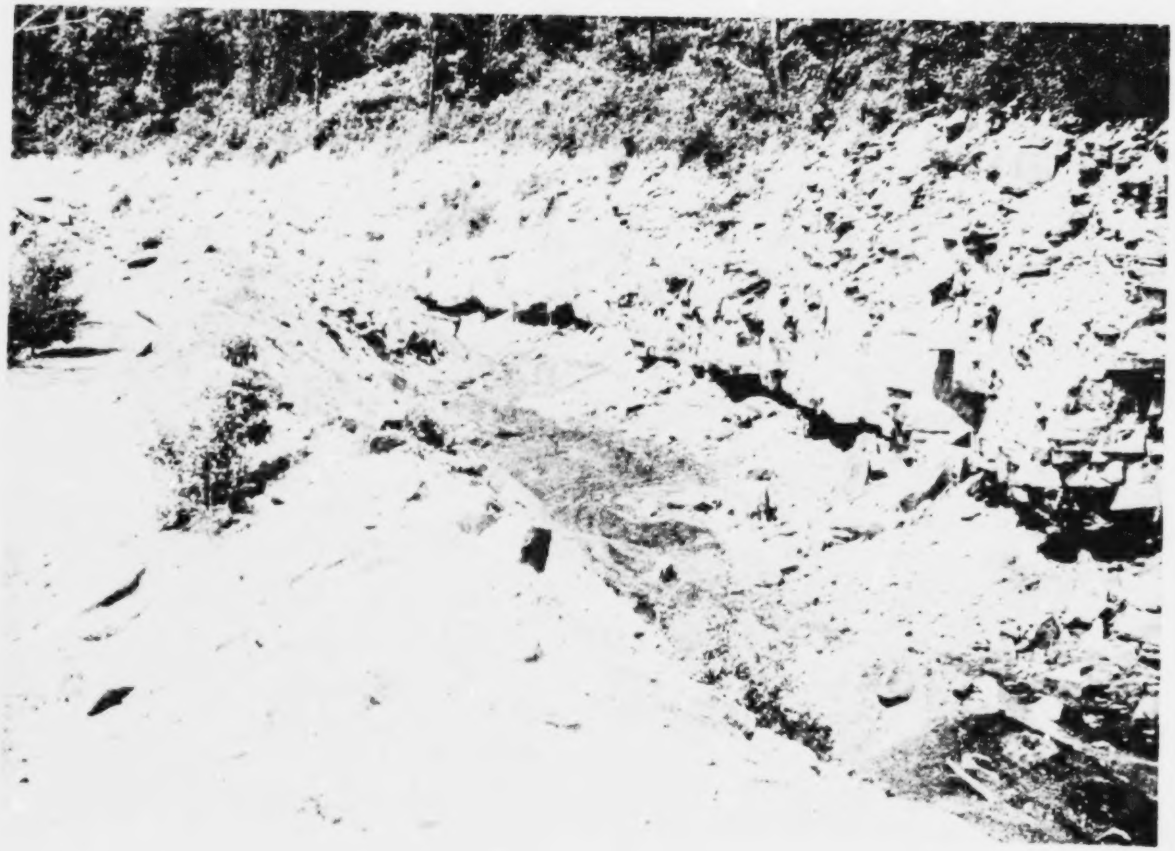
The height of the highwall in the west section is forty to fifty feet, the width of the bench varies from fifty feet to three hundred feet and the outslope is approximately forty feet high. The highwall is highly fractured since the area has been almost totally undermined by augering (see Figures 36 and 37). Many of the auger openings have cut into drift mine workings; therefore, the highwall is only supported by a small pillar of coal in several areas. There is no evidence of drainage either into or out of the auger openings; however, there is a ponded area at the extreme northwestern section of the strip approximately forty feet wide by one hundred twenty-five feet long. The water in the pond is highly discolored, indicating the presence of high concentrations of iron. The water was sampled on October 21, 1971, (refer to sample 39, Table 41).

The total length of both strip sections is approximately fifteen hundred feet. Reclamation work at this strip should include compaction sealing of the auger openings, contour backfilling (compacted), soil conditioning and seeding to establish a firm vegetative cover.

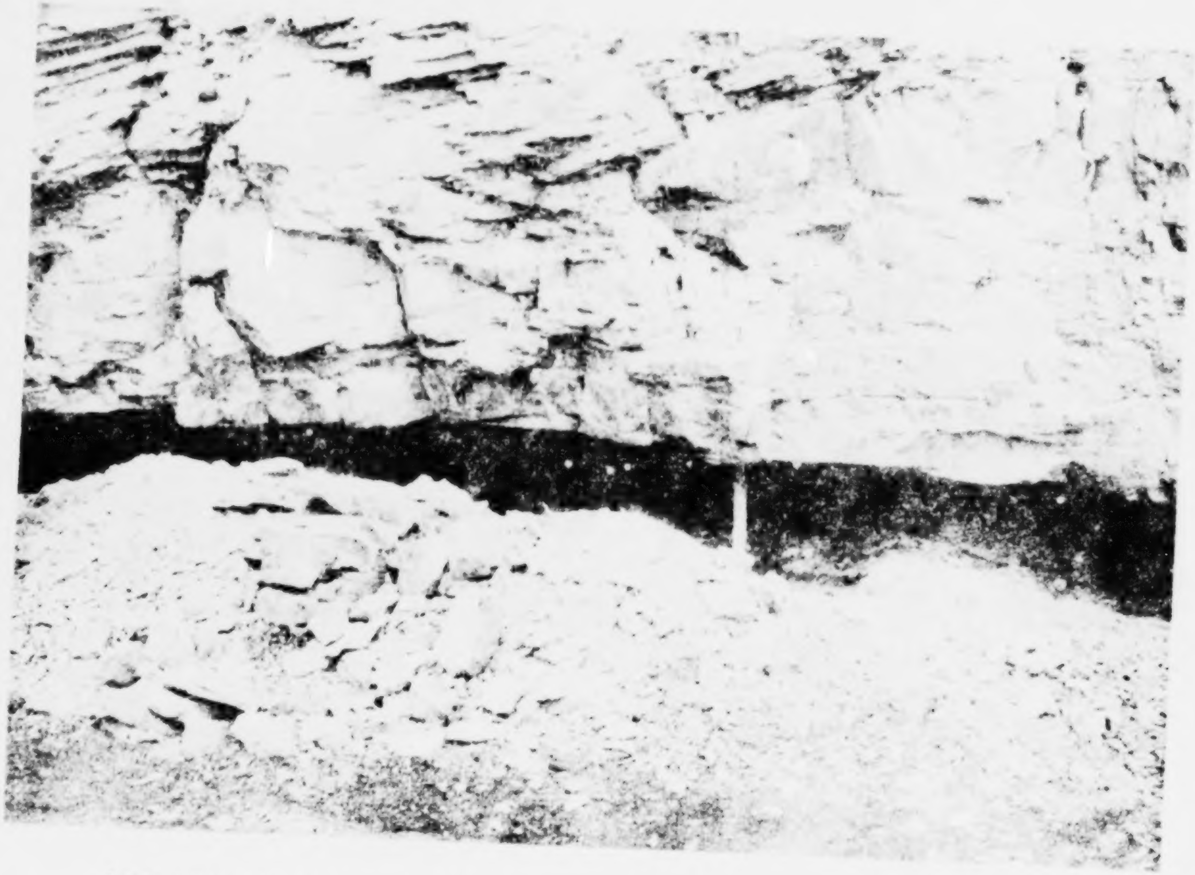
SECTION G - Strip Area W
Priority III (Waynesburg Coal)

The height of the highwall in strip area W is twenty to twenty-five feet, the width of the bench varies from seventy-five to two hundred feet and the height of the outslope is fifteen to twenty feet. Most of the area has been backfilled with what appears to be contour backfill.

Both the bench and outslope are presently covered with a heavy growth of trees and underbrush. The trees appear to be fifteen to twenty years old and consist predominantly



FRACTURED HIGHWALL RESULTING FROM EXTENSIVE AUGERING
SECTION G, STRIP AREA R
FIGURE 36



AUGERED AREA ILLUSTRATING EXTENT OF HIGHWALL UNDERMINING
SECTION G, STRIP AREA R
FIGURE 37

of pine. Natural weathering and erosion have reduced the height of the spoil banks and highwall to near original contour conditions.

There are three drift mine openings in the strip area. Drift mine openings 57 and 59 have either been covered or fallen in and do not require further sealing. Drift mine opening 58 has apparently been opened strictly for house coal. This opening is approximately four feet in diameter and the dimensions of the one small room that exists at this opening are approximately fifteen feet wide by twenty feet long. There is no evidence of drainage from any of these openings.

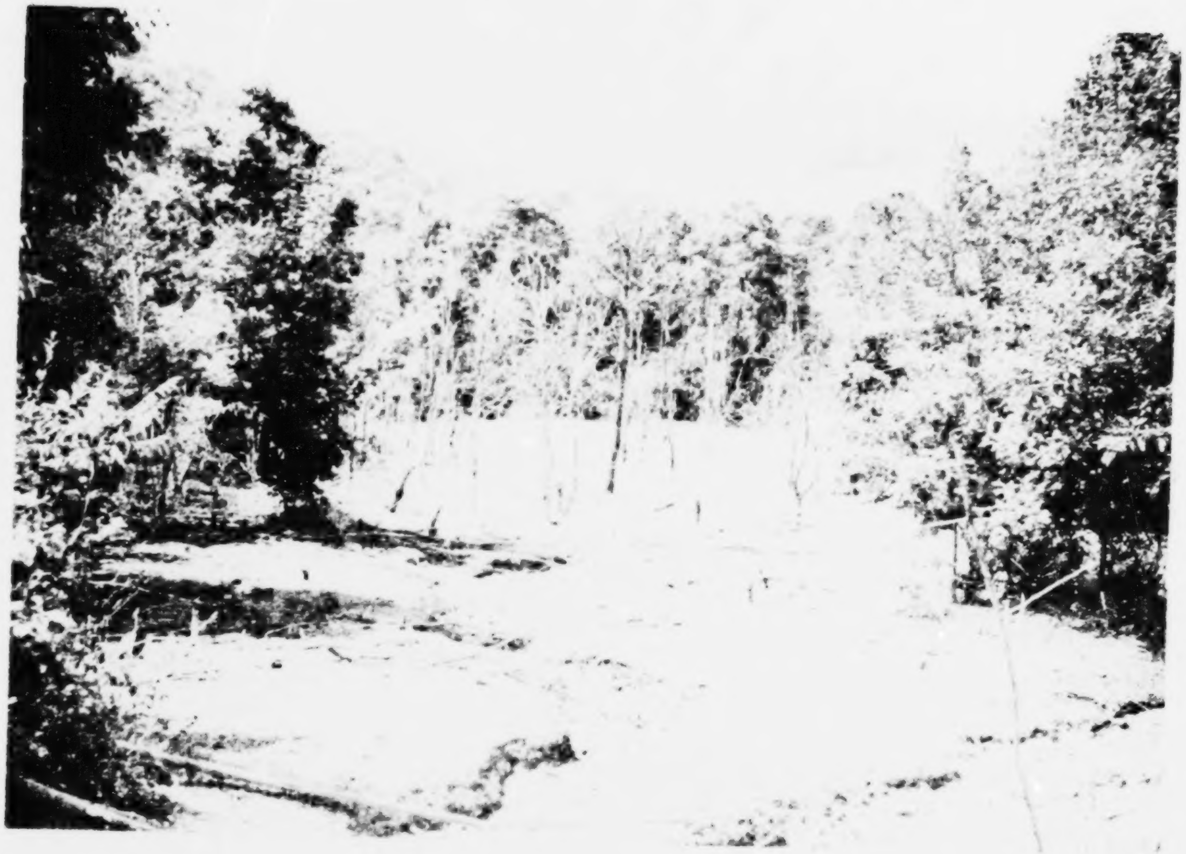
There are two "hot spots" immediately below the area. Each of the two areas is approximately fifty feet wide by two hundred feet long. The first area, immediately below drift mine opening 58, contains approximately one hundred dead trees (see Figure 38). The second area, below mine opening 57, is completely devoid of vegetative cover. Reclamation recommended at this strip site includes collecting soil samples from each of the "hot spot" areas and addition of whatever material may be required to establish a vegetative cover in the areas. Additional reclamation is not recommended at this site.

Program Surveillance

An important part of a demonstration project is the documentation of the effectiveness of the control measures being demonstrated. In the proposed project, tabulation of the quality and quantity of natural stream flows and borehole discharges in the watershed would show both the reduction of acid mine drainage as evidenced by Christopher Coal's reduced pumping rates, and the increase in stream quality due to the increase in natural surface water runoff.

The estimated stream flows observed during the course of this study are presented in Table 4.

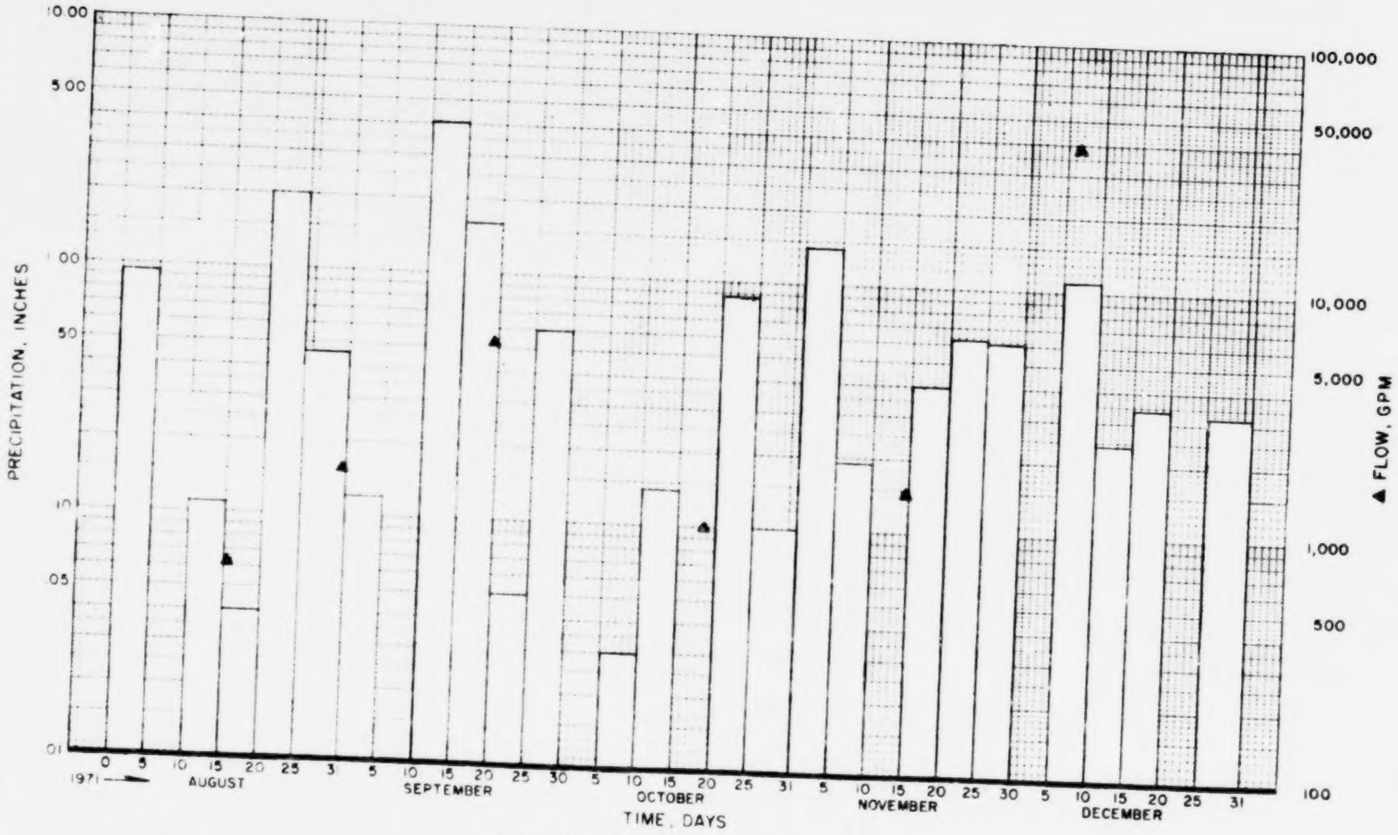
The relationship of stream flow to precipitation was correlated for each of the stream monitor locations in order to establish weir ratings. Figure 39 illustrates this correlation for Monitor Station No. 1.



"HOT SPOT" AREA
SECTION G, STRIP AREA W
FIGURE 38

TABLE 4
ESTIMATED STREAM FLOWS
8/30/71 THROUGH 2/25/72
FLOWS IN GPM

Monitor Station	8/30/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72	2/11/72	2/25/72
1	2,020	5,335	980	1,960	39,400	16,200	11,205	29,581
2	200	450	187	84	4,480	1,188	706	971
3	100	280	117	74	420	297	392	373
4	3,110	5,400	1,120	1,620	26,930	21,663	8,785	27,603
5	4,040	5,390	1,337	2,673	28,160	16,159	10,530	-
6	185	845	45	297	6,536	2,228	891	3,735
7	5,300	4,540	1,569	1,688	26,800	13,469	6,750	25,599
8	2,660	990	93	79	11,300	4,019	5,400	6,570
9	450	3,185	1,634	713	26,800	8,406	3,240	15,687
10	15	2,925	450	392	21,364	3,375	2,025	15,859



MONITOR STATION I
PRECIPITATION & FLOW VS TIME

FIGURE 39

A network of seven stream monitor stations should be installed to record the transient qualitative and quantitative effects. These monitor stations should continuously record pH, conductivity and flow.

The proposed locations of the stream monitor stations in the watershed are indicated in Figure 12. The monitoring instrumentation for each station should be housed in a weatherproof-bulletproof enclosure which is mounted above a stilling well located upstream from the weir structure. A typical stream weir structure and monitor station are illustrated in Figure 40. The design for the monitor station enclosure is illustrated in Figures 41 and 42, General Arrangement and Schematic Diagram.

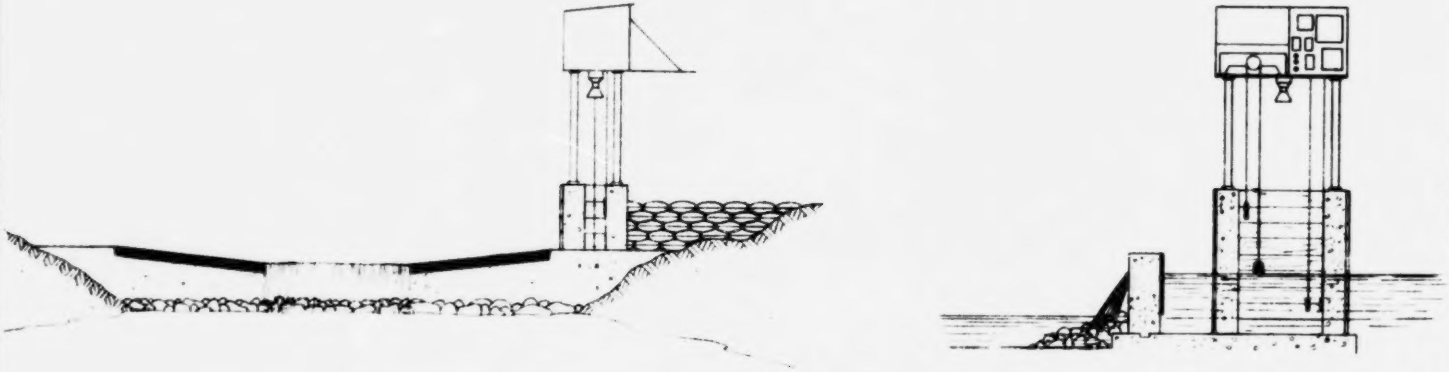
Since continuous measurement of all parameters of interest is not practical, measurement of the foregoing would, when correlated with spot sampling and laboratory analysis, allow reasonable estimates of the remaining parameters during the interval between samples. Samples should be taken on a weekly basis at each of the indicated stations and analyzed for pH, total iron, sulfate, turbidity, total acidity, alkalinity, and conductivity.

Samples should be collected at monthly intervals at both the stream monitor stations and borehole discharges, and analyzed for alkalinity, total acidity, conductivity, pH, turbidity, calcium, magnesium, sulfate, total iron, ferrous iron, total solids, suspended solids, dissolved solids, settleable solids, aluminum and manganese.

Due to the relative inaccessibility and sporadic operation of the borehole discharge pumps, accurate pumping data is not available. This information could be obtained by installing weir plates and event recorders at each of the borehole locations.

By an effective program of monitoring it can be shown that the acid mine drainage has not simply been diverted from underground to surface water courses. The monitoring program should begin following the feasibility study and continue for the duration of the demonstration project (approximately two years).

In addition to the foregoing stream monitoring stations, a recording rain and snow gauge should be installed near the center of the watershed.

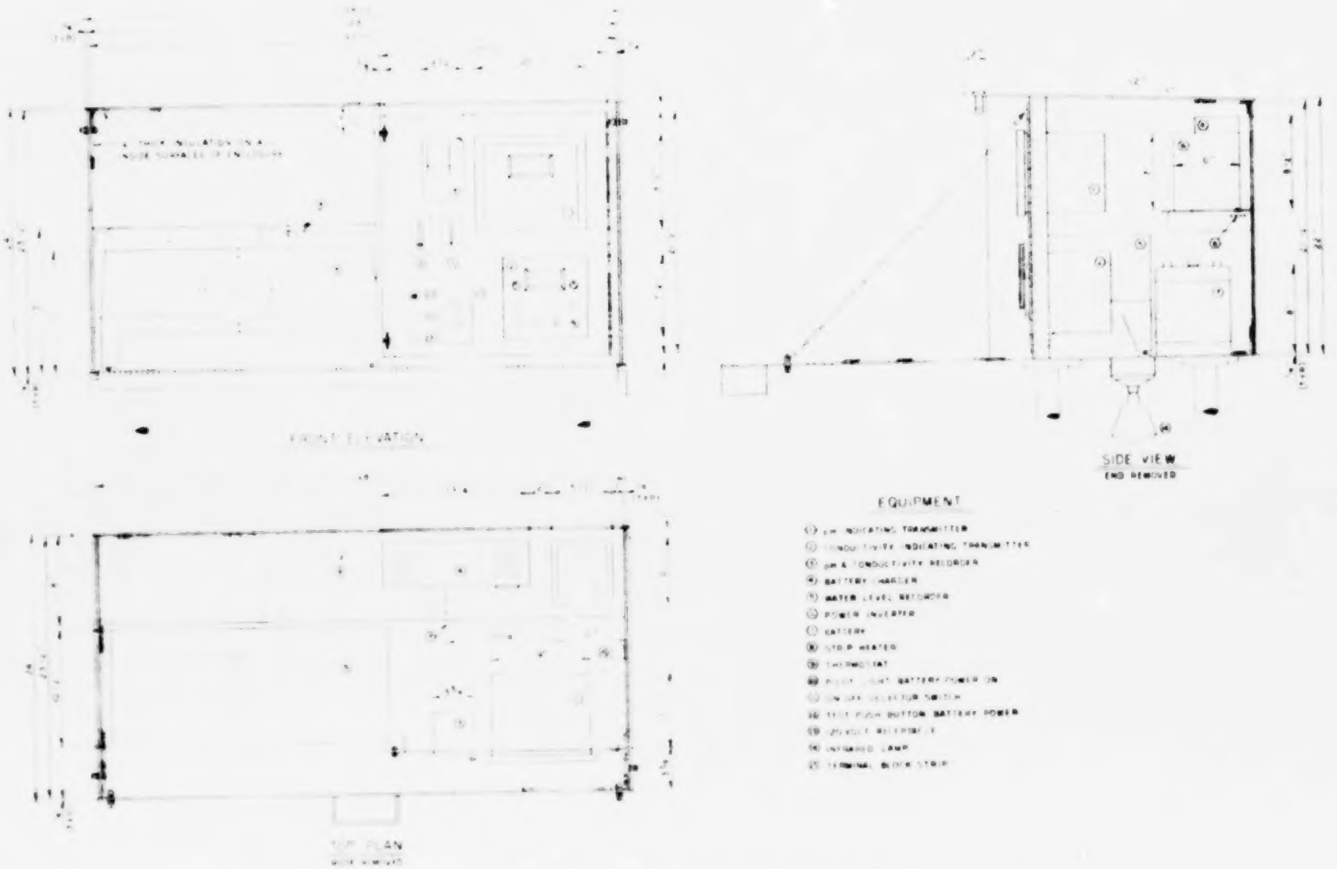


VIEW LOOKING UPSTREAM

VIEW AT OPERATOR STATION

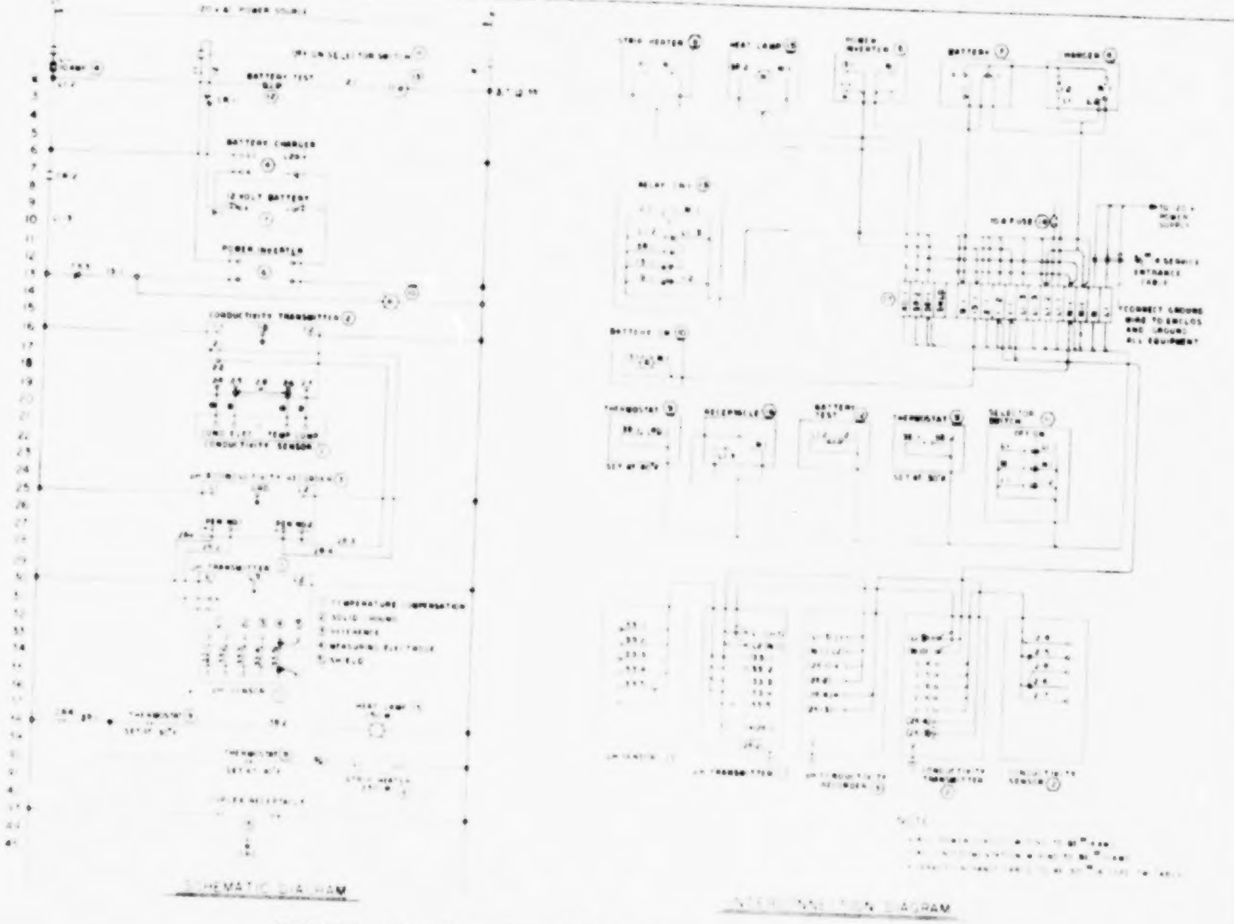
TYPICAL WEIR STRUCTURE AND MONITOR STATION

FIGURE 40


FRONT ELEVATION
SIDE VIEW
END REMOVED
TOP PLAN
EQUIPMENT
1 pH INDICATING TRANSMITTER
2 CONDUCTIVITY INDICATING TRANSMITTER
3 pH & CONDUCTIVITY RECORDER
4 BATTERY CHARGER
5 WATER LEVEL RECORDER
6 POWER INVERTER
7 BATTERY
8 STRIP HEATER
9 THERMOSTAT
10 PILOT LIGHT BATTERY POWER ON
11 ON-OFF SELECTOR SWITCH
12 TEST PUSH BUTTON BATTERY POWER
13 120-VOLT RECEPTACLE
14 INFRARED LAMP
15 TERMINAL BLOCK STRIP

MONITOR STATION - GENERAL ARRANGEMENT

FIGURE 41


POWER SOURCE
BATTERY TEST
BATTERY CHARGER
12 VOLT BATTERY
POWER INVERTER
CONDUCTIVITY TRANSMITTER
CONDUCTIVITY SENSOR
TRANSMITTER
TEMPERATURE COMPENSATION
SOLID GROUND
REFERENCE
MEASURING ELECTRODE
SHIELD
THERMOSTAT
SET AT
HEAT LAMP
STRIP HEATER
SCHEMATIC DIAGRAM
STRIP HEATER
HEAT LAMP
POWER INVERTER
BATTERY
HEATER
RELAY
FUSE
TO POWER SUPPLY
ENTRANCE CABLE
CONNECT GROUND WIRE TO ENCLOS AND GROUND ALL EQUIPMENT
BATTERY
THERMOSTAT
RECEPTACLE
BATTERY TEST
THERMOSTAT
SET AT
SELECTOR SWITCH
CONDUCTIVITY TRANSMITTER
CONDUCTIVITY SENSOR
NOTE
INTERCONNECTION DIAGRAM

MONITOR STATION - SCHEMATIC & INTERCONNECTION DIAGRAM

FIGURE 42

All recording charts should be collected at weekly intervals; the information from these charts and from periodic water sample analyses should be tabulated and a program developed to transmit the data in a format compatible with the Environmental Protection Agency computer facilities.

Monitor stations, as proposed, would operate from a primary 120 volt AC source supplied from local utility lines. In the event of a power failure of this primary system, a standby battery power source would be automatically energized. The battery circuit has provisions for testing during routine service inspections.

The battery circuit would function without interruption and the operation of monitoring instrumentation would not be adversely affected. In order to eliminate excessive drain on the battery, the heat lamp and strip heater should not operate on the battery circuit. The battery has the capability of powering the instruments continuously for a period of approximately 20 hours. In the event data recording would be acceptable on a cycled sequence, 2 minutes every 15 minutes, the battery would have the capability of providing power for a period of approximately 6 days. When this circuit is operating from the primary source, the battery charger will recharge the battery to its full capacity and shut off automatically.

When the primary power is restored, the power and control functions are automatically switched back to this source.

The topography of the Dents Run Watershed is such that surface mining techniques have often been employed to mine the coal outcrop at opposing sides of a mountain as is illustrated in Figure 6. Many of these surface mining operations have intercepted deep mine workings. Since the dip of the coal and other substrata is to the west in this area, water that falls on the unreclaimed surface mines on the eastern slopes of these hillsides is generally diverted into the deep mine workings or is impounded in the abandoned strip pit.

It is theorized that the drainage from several of the drift mine openings in the watershed originates as surface water which has been diverted into interconnected abandoned deep mine workings through either unreclaimed strip pits or surface mines which have employed the reverse terrace backfill method (see Figures 17 and 18).

The following discharges are believed to be the result of such interconnections:

Section G, Strip Area D, Mine Openings 23 through 29
Section G, Strip Area M, Mine Opening 38
Section G, Strip Area Q, Mine Openings 52 and 53

These locations should be established as secondary monitoring points to observe the effectiveness of reclamation work on the reduction of surface water infiltration.

Capital and Operating Costs

As previously mentioned, no acquisition costs should be involved for the purchase of land, minerals or water rights. The use of the demonstration area would be by consent of the individual property owners of the affected land within the watershed.

A cost estimate has been prepared for the completion of the reclamation work required in the Dents Run Watershed. The costs of regrading were based on an estimated average of $0.35 per cubic yard. Incidental costs such as dismantling and/or removal of abandoned equipment and automobiles, compaction of backfill material, treatment of water impoundments, etc., were also included in the estimated reclamation costs. The revegetation costs reflect the costs of soil analyses, limestone treatment, fertilization, hydroseeding, mulching (as required) and supplemental treatment of areas where revegetation was not successful on the first planting. The following is a breakdown of these costs by priority ranking:

PRIORITY I - INFILTRATION

Stream Channelization

Provisions for stream bed 500' long x 25' wide	$130,000

PRIORITY I (Cont'd)

Section G, Strip Area R (16 acres)

Reclamation - contour backfill 128,000 C.Y. @ $0.35	$ 44,800	
Compaction backfill 1500 L.F., 2 ft. layers, 10 ft. deep	4,500	
Disposal 30 derelict automobiles	1,500	
Riprap - outslope drainways 3 @ 100 ft. each	4,500	
Revegetation - fertilizer, grasses and trees - $500/acre	8,000	
Subtotal		$ 63,300

Section G, Strip Area A (10 acres)

Reclamation - pasture backfill 32,000 C.Y. @ $0.35	$ 11,200	
Compaction backfill 1000 L.F., 2 ft. layers, 10 ft. deep	3,000	
Riprap - outslope drainways 3 @ 100 ft. each	4,500	
Revegetation - fertilizer, grasses and trees - $500/acre	5,000	
Subtotal		$ 23,700

Section C, Strip Area C (2 acres)

Reclamation - pasture backfill 24,000 C.Y. @ $0.35	$ 8,400	
Compaction backfill 100 L.F., 2 ft. layers, 10 ft. deep	600	
Riprap - outslope drainway 100 ft.	1,500	
Revegetation - fertilizer, grasses and trees - $500/acre	1,000	
Subtotal		$ 11,500

PRIORITY I (Cont'd)

Section G, Strip Area J (9 acres)

Reclamation - contour/pasture backfill - 60,000 C.Y. @ $0.35	$ 21,000	
Compaction backfill 1000 L.F., 2 ft. layers, 10 ft. deep	3,000	
Compaction sealing - fracture zone	2,500	
Riprap - outslope drainways 2 @ 100 ft. each	3,000	
Revegetation - fertilizer, grasses and trees - $500/acre	4,500	
Subtotal		$ 34,000
Strip Areas - Subtotal		$132,500
Stream Channel - Subtotal		130,000
PRIORITY I - TOTAL		$262,500

PRIORITY II - SURFACE WATER POLLUTION

Section G, Strip Area G (6 acres)

Reclamation - contour/pasture backfill - 56,000 C.Y. @ $0.35	$ 19,600	
Mine bulkhead seals 3 @ $3,000	9,000	
Riprap - outslope drainways 3 @ 100 ft. each	4,500	
Revegetation - fertilizer, grasses and trees - $500/acre	3,000	
Subtotal		$ 36,100

PRIORITY II (Cont'd)

Section G - Mine Refuse Dump N (5 acres)

Reclamation - contour shaping 20,300 C.Y. mix and move @ $0.35	$ 7,105	
Flyash conditioning 6200 T. @ $1.35/T	8,370	
Riprap - outslope drainways 3 @ 125 ft. each	5,625	
Revegetation - fertilizer, grasses, mulch and asphalt tack - $500/acre	2,500	
Subtotal		$ 23,600

Section C, Strip Areas J and H (12 acres)

Reclamation - contour backfill 65,000 C.Y. @ $0.35	$ 22,750	
Mine bulkhead seals 3 @ $3,000	9,000	
Dismantle and remove tipple and abandoned mine buildings	6,000	
Treat acid mine water impoundment - 15,000 gal.	500	
Riprap - outslope drainways 2 @ 100 ft.	3,000	
Revegetation - fertilizer, grasses and trees - $500/acre	6,000	
Subtotal		$ 47,250

Section G, Strip Areas D and E (5 acres)

Reclamation - pasture backfill 40,000 C.Y. @ $0.35	$ 14,000	
Flyash conditioning 1500 T @ $1.35/T	2,025	
Riprap - outslope drainways 2 @ 100 ft. each	3,000	
Revegetation - fertilizer, grasses and trees - $500/acre	2,500	
Subtotal		$ 21,525

PRIORITY II (Cont'd)

Section G, Strip Area M (4 acres)

Reclamation - contour backfill 13,400 C.Y. @ $0.35	$ 4,690	
Mine bulkhead seal	3,000	
Riprap - outslope drainways 2 @ 100 ft. each	3,000	
Revegetation - fertilizer, grasses and trees - $500/acre	2,000	
Subtotal		$ 12,690

Section G, Strip Area C (9.5 acres)

Revegetation only		
Soil conditioning - limestone @ $100/acre	$ 950	
Riprap - outslope drainways 3 @ 100 ft. each	4,500	
Revegetation - fertilizer grasses and trees - $500/acre	4,750	
Subtotal		$ 10,200

Section F, Strip Area A (7 acres)

Reclamation - contour backfill 60,000 C.Y. @ $0.35	$ 21,000	
Riprap - outslope drainways 2 @ 100 ft. each	3,000	
Revegetation - fertilizer, grasses and trees - $500/acre	3,500	
Subtotal		$ 27,500

Section C, Strip Area S (3 acres)

Supplemental revegetation		
Flyash - 1,200 T @ $1.35/T	$ 1,620	
Soil conditioning - limestone @ $100/acre	300	
Revegetation - fertilizer, grasses and trees - $500/acre	1,500	
Subtotal		$ 3,420

PRIORITY II (Con't)

Section G, Strips Areas P and Q (29 acres)

Reclamation - pasture backfill 195,000 C.Y. @ $0.35	$ 68,250	
Mine bulkhead seals 3 @ $3,000	9,000	
Riprap - outslope drainways 4 @ 100 ft. each	6,000	
Revegetation - fertilizer, grasses and trees $500/acre	14,500	
Subtotal		$ 97,750

Section G, Strip Area B (3 acres)

Supplemental revegetation only

Flyash conditioning 1200 T @ $1.35	$ 1,620	
Riprap - outslope drainways 2 @ 100 ft. each	3,000	
Revegetation - fertilizer grasses and trees - $500/acre	1,500	
Subtotal		$ 6,120

Section C, Strip Area B (21 acres)

Reclamation pasture backfill 220,000 C.Y. @ $0.35	$ 77,000	
Treat acid mine water impoundment - 3 million gal.	1,000	
Removal of abandoned mine equipment	750	
Riprap - outslope drainways 3 @ 100 ft. each	4,500	
Revegetation - fertilizer, grasses and trees - $500/acre	10,500	
Subtotal		$ 93,750
PRIORITY II - TOTAL		$379,905

Stream Monitor Stations

Installation -

Monitor Station	No. 1	-	$13,600
	No. 2	-	2,070
	No. 3	-	2,150
	No. 4	-	9,500
	No. 6	-	3,450
	No. 7	-	8,040
	No. 9	-	6,200
	Subtotal		$45,010

Construction Costs

PRIORITY I	-	$262,500
PRIORITY II	-	379,905
Monitor Stations	-	45,010
TOTAL		$687,415

Effectiveness of Project

Since the Dents Run Watershed does receive the discharge from a considerable number of sources of acid mine water and is a major source of water for public and industrial use, it would serve as an ideal demonstration area in which to measure the effects of good infiltration control techniques and methods. Unfortunately, there is very little published data available on the quality of the various feeder streams from the individual mine sites. However, based on the representative sampling performed during this study, it can be seen that the Dents Run Watershed is a contaminated stream system and will continue to be so until corrective action is taken.

The implementation of the demonstration project is expected to show that proper restoration and revegetation of the various mine sites and waste dumps in the area will virtually eliminate the high level of acid mine drainage now present. It will require a period of time (approximately two years) for significant changes to materialize since allowance must be made for sufficient growing seasons to establish good vegetative cover and the subsequent stabilization of the new environmental conditions created. Certainly, the direct contact of air and water with the mineral rock, refuse and waste materials at the sites will be greatly reduced, if not eliminated in most instances; resulting in the inhibition of the standard chemical reactions which produce acid mine water. The effectiveness of the work performed at the various sites will be measured by the placement of monitor stations at select points in the watershed. Such monitoring should be established before the site work is performed, allowing the establishment of base data for the existing conditions, as well as the progressive changes in readings that will occur as site reclamation proceeds, vegetative cover is established and the new environmental equilibrium condition emerges.

The concept of this project, when placed in wider use, can do much to improve the quality of the waters of the State of West Virginia. This is important to the public in that streams can be restored to adequate quality to encourage the development of recreational activity, and provide an acceptable water supply for industrial and public use.

Schedule of Engineering and Construction

The project as originally scheduled established that the engineering phase would be completed and approved prior to the initiation of any construction activities. In order to take advantage of ideal construction weather during the fall of 1972, it is recommended that the engineering and construction phases run concurrently. This would permit the completion of regrading work on all Priority I areas before the winter season.

A schedule identifying the engineering and construction time spans has been developed and is illustrated in Figure 43.

The schedule for the remaining phases of the Grant, including the reporting schedule, is shown in Figure 44.

FIGURE 43 - ENGINEERING & CONSTRUCTION SCHEDULE

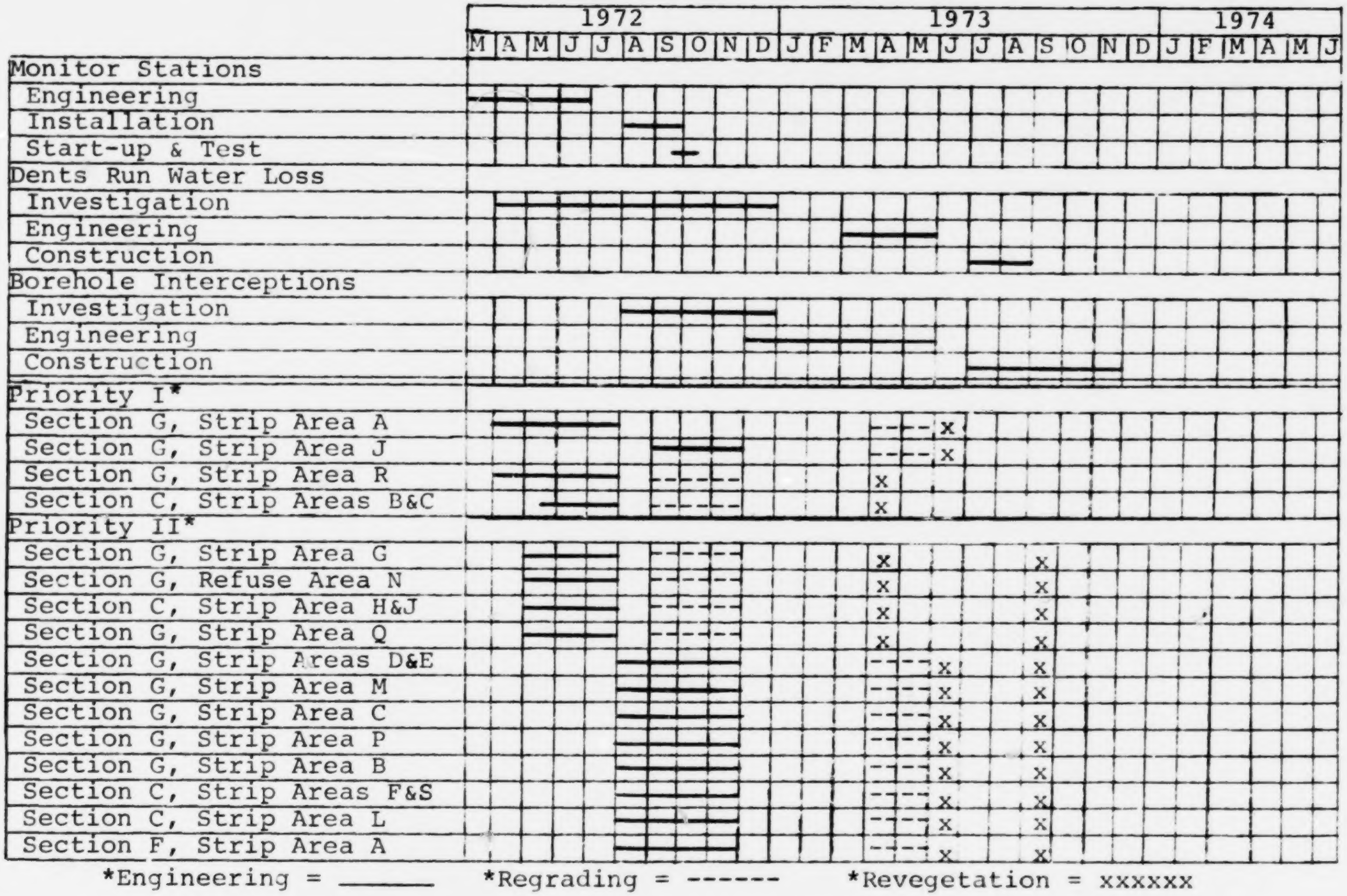
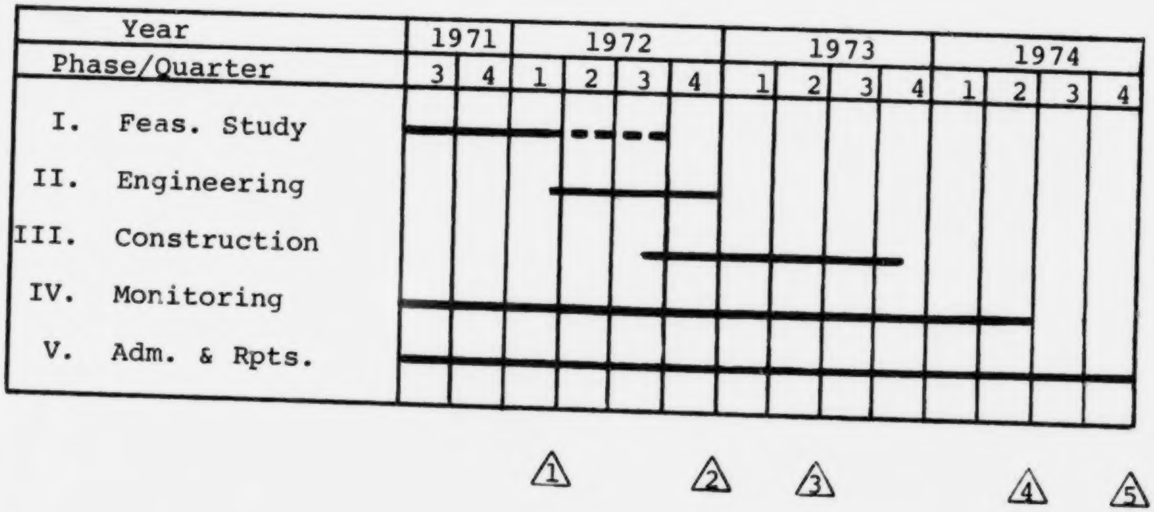


FIGURE 44
PROJECT SCHEDULE AND MILESTONES



- △1 Feasibility Report
- △2 Engineering Report
- △3 First Year Report
- △4 Second Year Report
- △5 Final Report

Collecting and Evaluating Data

The data logging instrumentation required to effectively record the parameters that will document the effectiveness of the control measures proposed in this study are discussed in the section "Program Surveillance" and illustrated in Figure 12. These are:

Stream Monitor Stations	7
Borehole Flow Recorders	5

In order to maintain a continuous flow of information pertinent to the project, the data handling system as identified in Figure 45 should be initiated as each unit is installed.

Implementation and Operating Plan

The West Virginia Department of Natural Resources, Division of Water Resources, would have full authority and responsibility for the demonstration program. This agency would provide for routine servicing for all recording instruments, maintenance of stream gauging stations and weir structures, and periodic collection of water samples from monitor station locations, boreholes and selected sample points.

The engineering and construction schedule that should be implemented during Phase II and Phase III of this project is illustrated in Figure 43. The proposed project schedule and milestones are shown in Figure 44. The construction of the monitor stations would extend over a period of approximately two months, preferably during July and August when low water conditions prevail. The reclamation work would require a period of approximately one year.

Construction bids should be obtained, evaluated and contracts awarded during Phase III. Bids would be based on standard uniform specifications. Contracts should be awarded to the lowest responsible bidder, taking into consideration the qualifications of the bidder, conformity of the proposal with the specifications, approval by the Federal government, performance schedule and budget limitations. Cyrus Wm. Rice Division - NUS Corporation should provide construction supervision assistance to the Division of Water Resources.

FIGURE 45
DATA HANDLING - TASKS AND RESPONSIBILITIES

	TASK	RESPONSIBILITY			FREQUENCY		
		WR-M	WR-C	CWR	AS REQ'D	WEEK	MONTH
1.	Collect all Strip Charts	X				X	
2.	Read Strip Charts & Record on Tabular Format		X			X	
3.	Transmit Charts to Charleston Office	X				X	
4.	Collect Stream Samples	X					X
5.	Collect Water Samples	X			X		
6.	Transmit Samples for Analyses	X			X		
7.	Water Analyses			X	X		
8.	Transmit Analyses Report to Charleston Office			X	X		
9.	Prepare Graphical Presentation & Computer Input Forms		X	X		X	
10.	Prepare Monthly Report & Transmit Data to EPA, Cincinnati		X	X			X

WR-M = Water Resources Division, Morgantown
WR-C = Water Resources Division, Charleston
CWR = Cyrus Wm. Rice Division - NUS Corporation

The proposed reports as indicated in Figure 43 would be prepared by Cyrus Wm. Rice Division - NUS Corporation personnel in cooperation with the Division of Water Resources.

A detailed listing of tasks and responsibilities for the monitoring phase is illustrated in Figure 46.

Construction and operation of the acid mine water neutralization plants for the borehole discharges would be the responsibility of the Christopher Coal Division-Consolidation Coal Company. Christopher Coal has submitted a schedule for completion of the required treatment plants; this construction will run concurrently with the reclamation work being done. The communities of Westover, Granville, and Laurel Point, as well as the individual residents of the watershed, should be required to abate the discharge of untreated sewage into Dents Run.

FIGURE 46
MONITOR STATIONS
TASKS AND RESPONSIBILITIES

TASK		RESPONSIBILITY			FREQUENCY			
		WR-M	WR-C	CWR	AS REQ'D	DAY	WEEK	MONTH
1.	Operation & Maintenance Manual			X	X			
2.	Operator Instruction			X	X			
3.	Unit Start-up			X	X			
4.	Check & Inspect all Stations		X	X				X
	Check & Inspect all Stations	X					X	
5.	Check & Inspect Rain Gauge	X					X	

WR-M = Water Resources Division, Morgantown
WR-C = Water Resources Division, Charleston
CWR = Cyrus Wm. Rice Division - NUS Corporation

SECTION VII

ACKNOWLEDGMENTS

The advice and guidance of Mr. E. N. Henry, Chief, Division of Water Resources; Mr. J. Hall, Assistant Chief, Division of Water Resources; Mr. D. E. Caldwell, Head, Mine Drainage Section; Mr. B. C. Greene, Chief, Division of Reclamation; and Mr. J. D. Brackenrich, Chief Engineer of the West Virginia Department of Natural Resources is sincerely appreciated.

Mr. W. A. Light, Environmental Quality Control Manager, and Mr. V. H. Ream, Manager of Water Treatment, Christopher Coal Division of Consolidation Coal Company, supplied mining maps, borehole pumping data, core boring logs and gave technical support during the investigative portion of this study.

The support of the project by the Office of Research & Monitoring of the Environmental Protection Agency and the help provided by Mr. Ronald D. Hill, Mr. Elmore C. Grim, Mr. Robert B. Scott, the Project Officer, and Mr. Ernst P. Hall, Chief of the Pollution Control Analysis Branch, is acknowledged with sincere thanks.

The primary investigators of this study were Mr. Frank J. Zaval, Project Manager, Mr. John D. Robins, Project Engineer, and Mr. James O. McFarland, Engineering Assistant, of the Cyrus Wm. Rice Division - NUS Corporation.

SECTION VIII

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SECTION IX

GLOSSARY OF TERMS, ABBREVIATIONS AND SYMBOLS

1. Auger Mining: mining of coal from an exposed vertical coal face by means of a mechanically-driven boring machine which employs an auger to cut and remove the coal.

2. Backfill: to place material back into an excavation and return the area to a predetermined slope.

3. Bench: the leveled surface of an excavated area measured horizontally at any point in the overburden or spoil between the base of the highwall and the outer point of original fill bench, or a working base extending from the base of a highwall on which excavating equipment can set, move and operate.

4. Bench Width: the width of the bench as measured horizontally from the base of the highwall to the outer point of the original fill bench.

5. Contour Surface Mining: the removal of overburden and the mining of mineral that normally approaches the surface at approximately the same elevation, a contour bench resulting.

6. Deep or Drift Mining: removal of the mineral being mined without the disturbance of the surface as distinguished from surface mining.

7. Diversion Ditch: a machine-made waterway used for collecting ground water or a ditch designed to change the actual or normal course of ground and/or surface water.

8. Georgia V-Ditch: a ditch for the collection of ground and surface water, constructed on the solid bench area, with the opposing slopes being constructed in such a manner so as to permit the total area to be transversed by farm equipment.

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9. Highwall: the vertical or near-vertical wall consisting of the exposed overlying strata after excavating operation.

10. Outer slope: the disturbed area extending from the outer point of the bench to the extreme lower limit of the disturbed land.

11. Reclamation: the process of converting disturbed land to a stable form for productive use.

12. Regrade or Grade: to change the contour of any surface by the use of leveling or grading equipment.

13. Spoil: all overburden material removed or displaced by excavating equipment, blasting or other means.

14. Stabilize: to settle, or fix in place by mechanical or vegetative means, including the planting of trees, grasses, vines, shrubs or legumes.

15. Seepage water: any water entering the ground from the surface through capillary action, cracks, faults, or any other natural mode of entry and finding its way to the surface again.

16. Storm water: any water flowing over or through the surface of the ground caused by precipitation; generally surface runoff.

17. Surface water: water, from whatever source, which is flowing on the surface of the ground.

SECTION X

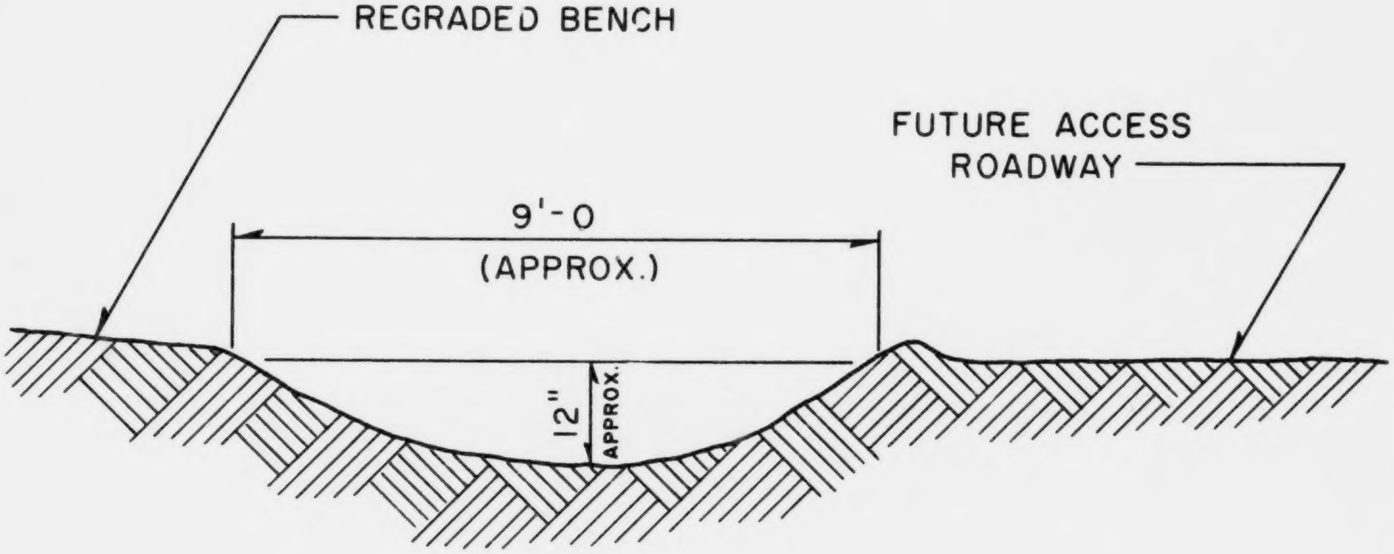
APPENDICES

DRAWINGS

Drawing No.	Title
6219-2A1	Watershed Plot Plan
6219-2A2	Monitor Station - General Arrangement
6219-2A3	Monitor Station Enclosure Details
6219-2A4	Dents Run Cross Section
6219-2A5	Hess Cross Section
6219-2A6	Enlarged Cross Section
6219-2A7	Level Recorder Enclosure Details
6219-2A8	Event Recorder - Plans & Details Six Right & Valotto
6219-2A9	Event Recorder - Plans & Details Snider & Hess
6219-2A10	Event Recorder - Plan & Detail Loar
6219-2A11	Survey Plan - Strip Area R - Section G
6219-2A12	Survey Plan - Strip Area A - Section G
6219-2A13	Survey Plan - Strip Areas B & C - Section C
6219-2A14	Survey Plan - Strip Area J - Section G
6219-2A15	Survey Plan - Strip Area G - Section G
6219-2A16	Survey Plan - Strip Area N - Section G
6219-2A17	Survey Plan - Strip Areas J & H - Section C
6219-2A18	Survey Plan - Strip Area D - Section G
6219-2A19	Survey Plan - Strip Area M - Section G
6219-2A20	Survey Plan - Strip Area C - Section G
6219-2A21	Survey Plan - Strip Area A - Section F
6219-2A22	Survey Plan - Strip Areas F & S - Section C
6219-2A23	Survey Plan - Strip Area L - Section C

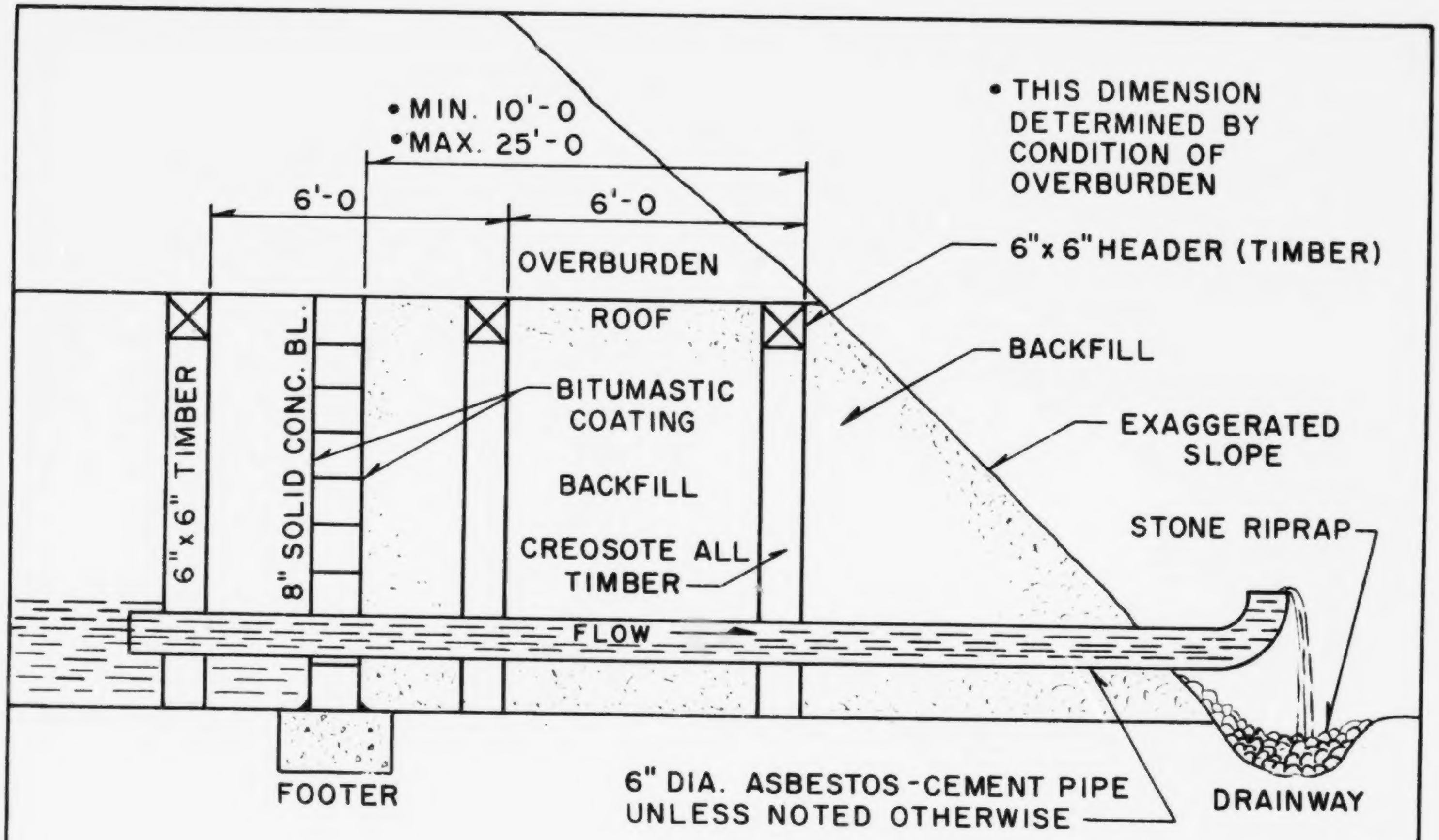
DRAWINGS (Cont'd)

Drawing No.	Title
6219-2A24	Survey Plan - Strip Area P - Section G
6219-2A25	Survey Plan - Strip Area Q - Section G
6219-2A26	Survey Plan - Strip Area B - Section G
6219-2A27	Survey Plan - Strip Area B - Section F
6219-2A28	Survey Plan - Strip Area C - Section F
6219-2A29	Survey Plan - Strip Area F - Section G
6219-2A30	Survey Plan - Strip Area H - Section G
6219-2A31	Survey Plan - Strip Area L - Section G
6219-3A1	Monitor Station 1 - Weir Arrangement
6219-3A2	Monitor Station 2 - Weir Arrangement and Details
6219-3A3	Monitor Station 3 - Weir Arrangement and Details
6219-3A4	Monitor Station 4 - Weir Arrangement and Details
6219-3A5	Monitor Station 5 - Weir Arrangement and Details
6219-3A6	Monitor Station 6 - Weir Arrangement and Details
6219-3A7	Monitor Station 7 - Weir Arrangement and Details
6219-3A8	Monitor Station 8 - Weir Arrangement and Details
6219-3A9	Monitor Station 9 - Weir Arrangement and Details
6219-3A10	Monitor Station 10 - Weir Arrangement and Details
6219-6A1	Monitor Station Schematic and Interconnection


REGRADED BENCH
FUTURE ACCESS ROADWAY
9'-0
(APPROX.)
12"
APPROX.

TYPICAL DIVERSION DITCH

FIGURE 47


• MIN. 10'-0
• MAX. 25'-0
6'-0
6'-0
OVERBURDEN
• THIS DIMENSION DETERMINED BY CONDITION OF OVERBURDEN
6"x 6" HEADER (TIMBER)
ROOF
BACKFILL
EXAGGERATED SLOPE
6"x6" TIMBER
8" SOLID CONC. BL.
BITUMASTIC COATING
BACKFILL
CREOSOTE ALL TIMBER
STONE RIPRAP
FLOW
FOOTER
6" DIA. ASBESTOS-CEMENT PIPE UNLESS NOTED OTHERWISE
DRAINWAY

BULKHEAD SEAL WITH RELIEF DRAIN

FIGURE 48

TABLE 5
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 1 ①

Date	8/16/71	8/31/71	9/20/71	10/19/71	10/21/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	620	2020	5334	980	-	1960	39400	16200
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	-	6.9	-
Free Acidity ($CaCO_3$)	820	200	33	617	550	194	-	40
Total Acidity ($CaCO_3$)	1280	640	119	816	1127	694	30	139
Conductivity (25°C) mmhos.	4190	3450	945	2770	3550	2540	650	1300
pH (electrometrically)	2.8	3.2	3.3	2.4	2.5	2.9	5.5	3.5
Color (APHA)	320	25	-	-	-	-	-	-
Turbidity (JTU)	72	140	-	-	-	-	-	-
Calcium (Ca)	470	281	94	231	265	346	66	100
Magnesium (Mg)	200	83	28	86	100	88	18	36
Hardness ($CaCO_3$)	1995	1043	-	931	1073	1226	238	398
Sulfate (SO_4)	3100	1480	570	1893	2380	1570	293	611
Total Iron (Fe)	280	76	95	134	184	102	106	48
Ferrous Iron (Fe)	16.8	11.5	5.1	20	23.5	12.3	10.6	6.8
Total Solids	4592	3480	1075	2985	3663	2482	2460	1093
Suspended Solids	20	128	141	102	83	115	1915	153
Dissolved Solids	4572	3352	934	2883	3580	2367	545	940
Settleable Solids (ml/l)	0.8	3.0	2.0	3.0	2.2	3.0	10.0	2.4
Aluminum (Al)	108	37	14	58	88.9	56.0	24.0	15.2
Manganese (Mn)	6.8	7.7	1.9	4.9	5.8	4.4	1.8	1.91
Chloride (Cl)	-	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	-	694	4	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 6
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 2 ①

Date	8/31/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	200	450	187	84	4480	1188
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	255	-
Free Acidity ($CaCO_3$)	560	394	942	571	-	221
Total Acidity ($CaCO_3$)	1080	780	1327	1142	106	407
Conductivity (25°C) mmhos.	4350	3730	4440	4100	1520	2370
pH (electrometrically)	3.0	2.9	2.2	2.7	6.7	2.8
Color (APHA)	75	-	-	-	-	-
Turbidity (JTU)	120	-	-	-	-	-
Calcium (Ca)	357	400	404	463	590	300
Magnesium (Mg)	151	142	208	174	62	80
Hardness ($CaCO_3$)	1512	-	1863	1871	1729	1078
Sulfate (SO_4)	2450	2500	3700	3124	1034	1314
Total Iron (Fe)	280	230	316	243	420	130
Ferrous Iron (Fe)	1.3	105	3.02	102	1.41	52.2
Total Solids	4878	4303	5660	4774	43536	2230
Suspended Solids	192	248	187	184	41780	277
Dissolved Solids	4686	4055	5473	4590	1756	1953
Settleable Solids (ml/l)	4.8	6.0	7.5	8.0	90	8.2
Aluminum (Al)	48	53	61.7	64	320	35
Manganese (Mn)	10.5	8.9	9.9	9.1	19	3.99
Chloride (Cl)	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	1142	2	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 7
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 3 ①

Date	8/31/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	100	50	117	74	420	297
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	-
Free Acidity ($CaCO_3$)	1640	658	1900	1734	458	1010
Total Acidity ($CaCO_3$)	3100	2080	3205	3010	624	1384
Conductivity (25°C) mmhos.	4700	3830	4300	4140	2000	3350
pH (electrometrically)	3.1	2.8	2.1	2.6	2.6	2.5
Color (APHA)	275	-	-	-	-	-
Turbidity (JTU)	70	-	-	-	-	-
Calcium (Ca)	398	380	438	428	232	290
Magnesium (Mg)	109	96	146	114	48	65
Hardness ($CaCO_3$)	1442	-	1694	1537	777	992
Sulfate (SO_4)	4370	3320	4461	3978	1214	2162
Total Iron (Fe)	680	500	580	610	106	375
Ferrous Iron (Fe)	26.3	20.4	7.55	20.6	7.42	27.0
Total Solids	7323	5907	7543	6488	2054	3675
Suspended Solids	9	11	138	58	150	60
Dissolved Solids	73	5896	7405	6430	1904	3615
Settleable Solids (ml/l)	<0.1	<0.1	2.0	<0.1	3	0.3
Aluminum (Al)	183	180	217	200	47	111
Manganese (Mn)	10.7	9.6	10.6	11.2	4.1	6.43
Chloride (Cl)	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	2930	644	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 8
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 4 ①

Date	8/30/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	3110	5400	1120	1620	26930	21663
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	0.5	-
Free Acidity ($CaCO_3$)	120	116	558	469	-	58
Total Acidity ($CaCO_3$)	420	322	1118	918	31.0	145
Conductivity (25°C) mmhos.	3600	1700	3100	2790	656	1350
pH (electrometrically)	3.2	3.1	2.6	2.8	4.5	3.4
Color (APHA)	5	-	-	-	-	-
Turbidity (JTU)	120	-	-	-	-	-
Calcium (Ca)	244	112	229	183	104	102
Magnesium (Mg)	91	44	104	72	21	32
Hardness ($CaCO_3$)	983	-	999	753	346	386
Sulfate (SO_4)	1750	910	2264	1686	287	669
Total Iron (Fe)	84	62	176	102	82	53
Ferrous Iron (Fe)	4.2	2.4	4.55	8.5	6.14	7.0
Total Solids	3435	1524	3573	2638	1021	1135
Suspended Solids	150	123	65	83	517	126
Dissolved Solids	3285	1401	3508	2555	504	1009
Settleable Solids (ml/l)	4.2	3.0	1.5	2.5	6	1.4
Aluminum (Al)	15.5	36	102	63	7.7	16
Manganese (Mn)	4.1	2.3	4.5	4.0	1.1	1.88
Chloride (Cl)	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	847	24	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 9
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 5 ①

Date	8/30/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	4040	1337	2673	28160	16159
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	7.4	-
Free Acidity ($CaCO_3$)	220	380	337	-	188
Total Acidity ($CaCO_3$)	620	812	826	33	382
Conductivity (25°C) mmhos.	3250	2600	2610	625	1980
pH (electrometrically)	3.2	2.7	2.9	5.8	2.8
Color (APHA)	15	-	-	-	-
Turbidity (JTU)	540	-	-	-	-
Calcium (Ca)	227	171	221	56	130
Magnesium (Mg)	85	69	76	18	10
Hardness ($CaCO_3$)	916	710	865	214	366
Sulfate (SO_4)	1990	1676	1513	169	895
Total Iron (Fe)	124	124	78	100	93
Ferrous Iron (Fe)	9.5	3.46	11.2	7.82	4.9
Total Solids	3649	2622	2400	2462	1482
Suspended Solids	156	100	116	1970	128
Dissolved Solids	3493	2522	2284	492	1354
Settleable Solids (ml/l)	6.3	5.5	4.5	11.0	5.0
Aluminum (Al)	40	76	54	19	22
Manganese (Mn)	4.0	2.8	3.3	1.2	3.9
Chloride (Cl)	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	765	10	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 10
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 6 ①

Date	8/20/71	8/30/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	140	185	844	45	297	6536	2228
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	15.9	-
Free Acidity ($CaCO_3$)	980	880	121	3	1050	-	80
Total Acidity ($CaCO_3$)	1540	1520	364	34	1693	34.8	183
Conductivity (25°C) mmhos.	8950	5800	2650	1800	4590	490	1500
pH (electrometrically)	2.9	3.0	3.0	4.4	2.5	6.1	3.2
Color (APHA)	190	140	-	-	-	-	-
Turbidity (JTU)	145	70	-	-	-	-	-
Calcium (Ca)	304	351	184	139	389	190	108
Magnesium (Mg)	155	177	72	47.9	156.0	9.2	42
Hardness ($CaCO_3$)	1396	1603	-	544	1613	513	442
Sulfate (SO_4)	3950	4870	1590	1033	3671	219	762
Total Iron (Fe)	680	340	104	7.3	380	136	66
Ferrous Iron (Fe)	39.8	1.9	11.7	1.02	59.4	5.54	15.6
Total Solids	6727	6525	2705	1617	5729	6684	1327
Suspended Solids	65	54	129	21	149	6244	192
Dissolved Solids	6662	6471	2576	1596	5580	440	1135
Settleable Solids (ml/l)	3.0	1.3	6.0	0.45	2.5	12.0	11.0
Aluminum (Al)	62	74	27	3	95	59	18
Manganese (Mn)	5.7	5.6	3.4	1.7	5.5	2.0	1.1
Chloride (Cl)	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	1612	8.0	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 11
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 7 ①

Date	8/20/71	8/30/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	-	5300	4320	1569	1688	26890	13469
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	22.4	8
Free Acidity ($CaCO_3$)	2030	100	196	850	785	-	-
Total Acidity ($CaCO_3$)	3140	480	480	1658	1377	19	47
Conductivity (25°C) mmhos.	8150	3600	1870	3400	3050	570	1160
pH (electrometrically)	2.8	3.1	3.0	2.5	2.5	6.9	4.8
Color (APHA)	330	12	-	-	-	-	-
Turbidity (JTU)	110	520	-	-	-	-	-
Calcium (Ca)	183	247	118	252	205	52	90
Magnesium (Mg)	167	96	46	104	83	14	32
Hardness ($CaCO_3$)	1142	1011	-	1056	853	187	356
Sulfate (SO_4)	4500	2210	1020	2802	2177	217	557
Total Iron (Fe)	520	112	120	290	216	44	35
Ferrous Iron (Fe)	28.8	10.6	16.9	9.2	15.9	4.36	6.6
Total Solids	7098	3410	1945	4419	3449	888	983
Suspended Solids	33	200	179	156	188	371	111
Dissolved Solids	7065	3210	1766	4263	3261	517	872
Settleable Solids (ml/l)	0.6	8.5	6.0	4.0	7	4	1.1
Aluminum (Al)	180	29	48	122	98.0	3.1	9.0
Manganese (Mn)	7.6	3.6	1.8	4.6	5.0	0.63	1.0
Chloride (Cl)	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	1377	12	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 12
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 8 ①

Date	8/30/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	2660	990	93	79	11300	4019
Pht. Alkalinity ($CaCO_3$)	-	-	0	-	-	-
M.O. Alkalinity ($CaCO_3$)	52	106	163.5	158	39.0	79
Free Acidity ($CaCO_3$)	-	-	-	-	-	-
Total Acidity ($CaCO_3$)	12.0	3.2	10.0	8.0	20.0	15
Conductivity (25°C) mmhos.	3950	810	1320	1090	845	1740
pH (electrometrically)	6.2	7.8	8.2	7.8	6.6	7.0
Color (APHA)	140	-	-	-	-	-
Turbidity (JTU)	580	-	-	-	-	-
Calcium (Ca)	241	62	124	106	76	132
Magnesium (Mg)	88	22	38	31	22	48
Hardness ($CaCO_3$)	963	-	466	392	280	527
Sulfate (SO_4)	1620	287	593	414	350	810
Total Iron (Fe)	60.0	0.50	0.29	0.23	160	36
Ferrous Iron (Fe)	9.6	0.17	0.233	0.041	9.5	10.0
Total Solids	2904	581	1128	813	1595	1419
Suspended Solids	122	4	1	1	898	61
Dissolved Solids	2782	577	1127	812	697	1358
Settleable Solids (ml/l)	0.7	<0.1	<0.1	<0.1	7	0.2
Aluminum (Al)	<0.1	<0.1	<0.1	<0.1	4.5	0.15
Manganese (Mn)	3.8	0.72	0.21	0.28	2.5	1.58
Chloride (Cl)	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	0	12	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 13
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 9 ①

Date	8/30/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	450	3362	1634	713	26890	8406
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	18.6	-
Free Acidity ($CaCO_3$)	980	206	813	275	-	56
Total Acidity ($CaCO_3$)	2280	458	1579	581	19.5	156
Conductivity (25°C) mmhos.	4450	1800	3250	2110	320	955
pH (electrometrically)	2.9	3.0	2.5	2.6	6.2	3.4
Color (APHA)	220	-	-	-	-	-
Turbidity (JTU)	170	-	-	-	-	-
Calcium (Ca)	193	98	230	205	36	60
Magnesium (Mg)	129	38	97	59	8.4	24
Hardness ($CaCO_3$)	1011	-	973	755	124	248
Sulfate (SO_4)	3410	936	2639	1156	117	414
Total Iron (Fe)	440	90	284	66	40	46
Ferrous Iron (Fe)	1.3	15.2	0.847	5.5	2.92	6.3
Total Solids	5647	1563	4093	1855	742	757
Suspended Solids	146	169	128	117	342	107
Dissolved Solids	5501	1394	3965	1738	400	650
Settleable Solids (ml/l)	5.7	6.0	4.0	5.0	6	2.7
Aluminum (Al)	141	40	122	46	3.1	18.0
Manganese (Mn)	6.2	1.6	4.4	3.2	0.40	0.69
Chloride (Cl)	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	571	16	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 14
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 10 ①

Date	8/19/71	8/30/71	9/20/71	10/19/71	11/15/71	12/7/71	1/14/72
Flow (gpm)	5	30	2925	450	392	21364	3375
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	190	162	99	165	164	49	98
Free Acidity ($CaCO_3$)	-	-	-	-	-	-	-
Total Acidity ($CaCO_3$)	10.0	4.0	5.6	6.0	4.0	8.9	2.0
Conductivity (25°C) mmhos.	560	500	440	595	535	240	389
pH (electrometrically)	7.9	8.0	7.6	7.9	8.0	7.0	7.9
Color (APHA)	25	2	-	-	-	-	-
Turbidity (JTU)	<5	<5	-	-	-	-	-
Calcium (Ca)	51	53	44	61	80	56	48
Magnesium (Mg)	13	13	12	17	21.0	8.8	16
Hardness ($CaCO_3$)	181	186	-	223	286	176	186
Sulfate (SO_4)	140	110	78	107	99	50	76.7
Total Iron (Fe)	0.39	0.21	0.23	0.16	0.10	3.0	0.15
Ferrous Iron (Fe)	0.184	0.073	0.18	0.093	0.056	0.594	0.041
Total Solids	349	372	340	333	329	324	220
Suspended Solids	10	5	13	4	2	119	<1.0
Dissolved Solids	339	367	327	329	327	205	220
Settleable Solids (ml/l)	<0.1	<0.1	0.1	0.1	0.1	0.6	<0.1
Aluminum (Al)	0.18	<0.1	-	0.3	0.1	1.2	0.17
Manganese (Mn)	0.06	0.05	<0.1	0.02	0.04	0.26	0.02
Chloride (Cl)	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	0	110	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 15
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 11 ①

Date	8/16/71	8/31/71	9/21/71	10/19/71	11/15/71	12/15/71	1/14/72
Flow (gpm)	100	60	35	56	56	-	-
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	0	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	0	-
Free Acidity ($CaCO_3$)	640	660	500	474	765	408	372
Total Acidity ($CaCO_3$)	990	1880	845	1071	1142	702	619
Conductivity (25°C) mmhos.	7780	4750	4350	4560	4350	3800	4430
pH (electrometrically)	2.8	3.4	2.9	2.6	2.5	2.8	2.8
Color (APHA)	>1000	110	-	-	-	-	-
Turbidity (JTU)	560	100	-	-	-	-	-
Calcium (Ca)	-	494	560	491	515	520	530
Magnesium (Mg)	-	192	156	184	179	216	180
Hardness ($CaCO_3$)	2912	2022	-	1982	2022	2185	2063
Sulfate (SO_4)	4280	3720	2900	3299	3259	3100	2800
Total Iron (Fe)	290	300	250	244	286	240	245
Ferrous Iron (Fe)	68.3	38.6	25.3	3.32	16.5	61.6	76.0
Total Solids	5492	5224	5145	5119	593	5050	4948
Suspended Solids	136	112	263	94	90	377	553
Dissolved Solids	5356	5112	4882	5025	503	4673	4395
Settleable Solids (ml/l)	12.0	4.0	5.0	1.1	1.6	10.0	11.5
Aluminum (Al)	60.0	49.0	58.0	55.5	47	52	40
Manganese (Mn)	8.4	7.7	7.8	8.4	8.4	7.35	8.06
Chloride (Cl)	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	1142	784	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 16
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 12 ①

Date	8/16/71	8/31/71	9/20/71	10/19/71	11/15/71	12/15/71	1/14/72
Flow (gpm)	-	90	283	252	281	-	-
Pht. Alkalinity ($CaCO_3$)	200	-	-	-	-	0	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	0	-
Free Acidity ($CaCO_3$)	1830	2120	1400	2305	2275	1484	2196
Total Acidity ($CaCO_3$)	3240	3760	2880	3610	3662	2204	3651
Conductivity (25°C) mmhos.	9350	5070	4520	4590	4340	3750	4890
pH (electrometrically)	2.7	2.8	2.4	2.5	2.4	2.6	2.5
Color (APHA)	392	460	-	-	-	-	-
Turbidity (JTU)	60	80	-	-	-	-	-
Calcium (Ca)	-	242	420	436	460	377	400
Magnesium (Mg)	560	131	130	151	142	136	110
Hardness ($CaCO_3$)	2220	1142	-	1709	1732	1500	1451
Sulfate (SO_4)	5240	4560	4560	4996	4625	3690	4364
Total Iron (Fe)	950	800	980	760	640	620	924
Ferrous Iron (Fe)	493	2.4	362	5.05	8.1	157	279
Total Solids	8164	8464	8093	8227	7529	5403	7872
Suspended Solids	24	7	15	151	36	26	38
Dissolved Solids	8140	8457	8078	8076	7493	5377	7834
Settleable Solids (ml/l)	0.1	<0.1	<0.1	1.5	0.1	<0.011	0.1
Aluminum (Al)	260	244	250	260	208	189	236
Manganese (Mn)	9.0	10.8	9.4	10.1	10.9	8.2	10.0
Chloride (Cl)	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	3448	2320	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 17
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 13 ①

Date	8/16/71	8/30/71	9/20/71	10/19/71	11/15/71	12/15/71	1/14/72
Flow (gpm)	264	335	169	187	187	-	-
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	0	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	0	-
Free Acidity ($CaCO_3$)	480	1060	932	1408	1622	1810	1325
Total Acidity ($CaCO_3$)	1530	1880	1570	2142	2356	2630	2103
Conductivity (25°C) mmhos.	8640	6000	5500	5900	5560	5400	4910
pH (electrometrically)	2.9	3.1	2.9	2.5	2.4	2.6	2.5
Color (APHA)	280	240	-	-	-	-	-
Turbidity (JTU)	240	30	-	-	-	-	-
Calcium (Ca)	690	238	460	440	499	445	470
Magnesium (Mg)	310	218	192	202	200	236	220
Hardness ($CaCO_3$)	2996	1489	-	1928	2068	2080	2077
Sulfate (SO_4)	7610	4800	4510	5057	5058	4830	4367
Total Iron (Fe)	505	500	500	500	500	590	650
Ferrous Iron (Fe)	311	0.9	240	4.16	194	170	123
Total Solids	7720	7886	8027	7825	7862	7574	7774
Suspended Solids	16	75	122	196	196	40	347
Dissolved Solids	7704	7811	7905	7629	7666	7534	7427
Settleable Solids (ml/l)	6.0	2.1	2.0	5.0	0.7	0.4	4.2
Aluminum (Al)	78	93	82	114	117	141	137
Manganese (Mn)	7.4	6.3	5.6	5.8	6.6	5.8	6.74
Chloride (Cl)	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	2356	2040	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 18
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 14 ①

Date	8/30/71	12/7/71	1/14/72
Flow (gpm)	2800	-	-
Pht. Alkalinity ($CaCO_3$)	-	-	-
M.O. Alkalinity ($CaCO_3$)	48	58	106
Free Acidity ($CaCO_3$)	-	-	-
Total Acidity ($CaCO_3$)	52	190	177
Conductivity (25°C) mmhos.	3100	300	2920
pH (electrometrically)	5.8	5.6	6.1
Color (APHA)	110	-	-
Turbidity (JTU)	280	-	-
Calcium (Ca)	247	288	230
Magnesium (Mg)	91	88	85
Hardness ($CaCO_3$)	991	931	924
Sulfate (SO_4)	2020	1765	1538
Total Iron (Fe)	94	100	115
Ferrous Iron (Fe)	86	98	95.8
Total Solids	2951	3109	2663
Suspended Solids	72	112	52
Dissolved Solids	2879	2997	2611
Settleable Solids (ml/l)	0.2	0.2	<0.1
Aluminum (Al)	<0.1	0.13	0.15
Manganese (Mn)	3.9	4.0	3.82
Chloride (Cl)	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	10	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 19
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 15 ①

Date	8/16/71	8/30/71	9/20/71	10/19/71	11/15/71	12/15/71	1/14/72
Flow (gpm)	-	840	-	672	-	-	-
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-	0	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-	0	-
Free Acidity ($CaCO_3$)	2500	2380	1140	2940	2468	2710	2570
Total Acidity ($CaCO_3$)	4230	4420	3850	4428	4900	4600	4505
Conductivity (25°C) mmhos.	11430	6250	6600	5400	6660	5800	7070
pH (electrometrically)	2.4	2.8	2.6	2.4	2.4	2.4	2.3
Color (APHA)	400	510	-	-	-	-	-
Turbidity (JTU)	110	90	-	-	-	-	-
Calcium (Ca)	-	150	500	468	481	464	460
Magnesium (Mg)	-	205	220	241	241	270	230
Hardness ($CaCO_3$)	2962	1215	-	2158	2191	2267	2093
Sulfate (SO_4)	5480	4880	6090	6584	6831	6390	5698
Total Iron (Fe)	900	600	860	720	740	980	930
Ferrous Iron (Fe)	372	3.0	306	10.2	308	396	367
Total Solids	10708	11167	10792	10621	10657	10490	10102
Suspended Solids	4	19	26	<1	6.0	18.0	58
Dissolved Solids	10704	11148	10766	10620	10651	10472	10044
Settleable Solids (ml/l)	0.1	<0.1	<0.1	<0.1	0.05	<0.1	<0.1
Aluminum (Al)	170	292	350	328	302	357	319
Manganese (Mn)	9.6	10.7	10.0	10.4	11.7	11.0	11.6
Chloride (Cl)	-	-	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	4900	2520	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 20
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 16 ①

Date	8/16/71	8/30/71	9/20/71	10/19/71	11/16/71
Flow (gpm)	44	50	50	35	30
Pht. Alkalinity ($CaCO_3$)	-	-	-	-	-
M.O. Alkalinity ($CaCO_3$)	-	-	-	-	-
Free Acidity ($CaCO_3$)	2810	2000	850	2192	2330
Total Acidity ($CaCO_3$)	4260	3940	3590	3840	4000
Conductivity (25°C) mmhos.	10540	5400	4900	4720	4890
pH (electrometrically)	2.7	3.0	2.7	2.5	2.6
Color (APHA)	920	440	-	-	-
Turbidity (JTU)	330	110	-	-	-
Calcium (Ca)	620	-	460	460	-
Magnesium (Mg)	285	-	192	218	-
Hardness ($CaCO_3$)	2719	-	-	2044	-
Sulfate (SO_4)	7360	5550	5270	5556	5647
Total Iron (Fe)	1000	920	920	780	760
Ferrous Iron (Fe)	285	156	149	9.23	80.7
Total Solids	9762	9566	9554	9433	9193
Suspended Solids	52	109	35	199	48
Dissolved Solids	9710	9457	9519	9234	9145
Settleable Solids (ml/l)	2.0	1.5	<0.1	2.0	0.1
Aluminum (Al)	304	280	290	300	294
Manganese (Mn)	8.0	7.9	6.8	7.5	8.1
Chloride (Cl)	-	-	-	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-	-	-	4100

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 21
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 17 ①

Date	8/19/71
Flow (gpm)	5
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	340
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	0
Conductivity (25°C) mmhos.	1175
pH (electrometrically)	8.2
Color (APHA)	15
Turbidity (JTU)	5
Calcium (Ca)	29
Magnesium (Mg)	16
Hardness ($CaCO_3$)	138
Sulfate (SO_4)	365
Total Iron (Fe)	0.29
Ferrous Iron (Fe)	0.092
Total Solids	743
Suspended Solids	4
Dissolved Solids	739
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	<0.1
Manganese (Mn)	<0.02
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 22
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 18 ①

Date	8/19/71
Flow (gpm)	10
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	930
Total Acidity ($CaCO_3$)	1700
Conductivity (25°C) mmhos.	7150
pH (electrometrically)	2.9
Color (APHA)	200
Turbidity (JTU)	140
Calcium (Ca)	370
Magnesium (Mg)	114
Hardness ($CaCO_3$)	1392
Sulfate (SO_4)	3750
Total Iron (Fe)	364
Ferrous Iron (Fe)	11.9
Total Solids	5086
Suspended Solids	50
Dissolved Solids	5036
Settleable Solids (ml/l)	2.0
Aluminum (Al)	106
Manganese (Mn)	13.2
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 23
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 19 ①

Date	8/20/71	9/21/71
Flow (gpm)	25	37
Pht. Alkalinity ($CaCO_3$)	-	-
M.O. Alkalinity ($CaCO_3$)	-	-
Free Acidity ($CaCO_3$)	900	1140
Total Acidity ($CaCO_3$)	4090	6940
Conductivity (25°C) mmhos.	16500	9300
pH (electrometrically)	2.9	3.0
Color (APHA)	380	-
Turbidity (JTU)	270	-
Calcium (Ca)	145	380
Magnesium (Mg)	664	680
Hardness ($CaCO_3$)	3085	-
Sulfate (SO_4)	10054	9560
Total Iron (Fe)	2240	2940
Ferrous Iron (Fe)	1910	2150
Total Solids	16247	19661
Suspended Solids	129	438
Dissolved Solids	16118	19223
Settleable Solids (ml/l)	9.0	0.1
Aluminum (Al)	50	220
Manganese (Mn)	66.8	70.0
Chloride (Cl)	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 24
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 20 ①

Date	8/20/71
Flow (gpm)	-
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	160
Total Acidity ($CaCO_3$)	200
Conductivity (25°C) mmhos.	1250
pH (electrometrically)	3.3
Color (APHA)	10
Turbidity (JTU)	5
Calcium (Ca)	84
Magnesium (Mg)	41
Hardness ($CaCO_3$)	378
Sulfate (SO_4)	541
Total Iron (Fe)	5.0
Ferrous Iron (Fe)	0.804
Total Solids	994
Suspended Solids	2
Dissolved Solids	992
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	13.4
Manganese (Mn)	9.4
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 25
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 21 ①

Date	7/27/71
Flow (gpm)	-
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	412
Total Acidity ($CaCO_3$)	800
Conductivity (25°C) mmhos.	2950
pH (electrometrically)	2.7
Color (APHA)	70
Turbidity (JTU)	20
Calcium (Ca)	248
Magnesium (Mg)	87
Hardness ($CaCO_3$)	970
Sulfate (SO_4)	2250
Total Iron (Fe)	125
Ferrous Iron (Fe)	-
Total Solids	3596
Suspended Solids	64
Dissolved Solids	3532
Settleable Solids (ml/1)	0.5
Aluminum (Al)	65
Manganese (Mn)	5.9
Chloride (Cl)	7.86
Hot Pht. Acidity ($CaCO_3$)	-
Sodium	180
Potassium	5.5

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 26
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 22 ①

Date	8/16/71
Flow (gpm)	3-5
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	40
Total Acidity ($CaCO_3$)	640
Conductivity (25°C) mmhos.	7310
pH (electrometrically)	4.8
Color (APHA)	380
Turbidity (JTU)	245
Calcium (Ca)	675
Magnesium (Mg)	280
Hardness ($CaCO_3$)	2836
Sulfate (SO_4)	3550
Total Iron (Fe)	328
Ferrous Iron (Fe)	301
Total Solids	4722
Suspended Solids	110
Dissolved Solids	4612
Settleable Solids (ml/1)	3.0
Aluminum (Al)	6.4
Manganese (Mn)	5.8
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 27
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 23 ①

Date	8/20/71
Flow (gpm)	0.5
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	2130
Total Acidity ($CaCO_3$)	2760
Conductivity (25°C) mmhos.	6900
pH (electrometrically)	2.6
Color (APHA)	400
Turbidity (JTU)	80
Calcium (Ca)	128
Magnesium (Mg)	172
Hardness ($CaCO_3$)	1025
Sulfate (SO_4)	4250
Total Iron (Fe)	705
Ferrous Iron (Fe)	73.2
Total Solids	6634
Suspended Solids	21
Dissolved Solids	6613
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	108
Manganese (Mn)	20.4
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 28
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 24 ①

Date	8/20/71	9/20/71
Flow (gpm)	1-2	10
Pht. Alkalinity ($CaCO_3$)	-	-
M.O. Alkalinity ($CaCO_3$)	-	-
Free Acidity ($CaCO_3$)	580	508
Total Acidity ($CaCO_3$)	1150	1200
Conductivity (25°C) mmhos.	3800	2820
pH (electrometrically)	3.0	2.8
Color (APHA)	50	-
Turbidity (JTU)	10	-
Calcium (Ca)	297	300
Magnesium (Mg)	45	62
Hardness ($CaCO_3$)	927	-
Sulfate (SO_4)	1870	1890
Total Iron (Fe)	81	90
Ferrous Iron (Fe)	30.1	2.0
Total Solids	3251	3242
Suspended Solids	2.0	<1.0
Dissolved Solids	3249	3241
Settleable Solids (ml/l)	<0.1	<0.1
Aluminum (Al)	84	120
Manganese (Mn)	25.6	20.0
Chloride (Cl)	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 29
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 25 ①

Date	8/20/71	9/20/71
Flow (gpm)	1-2	135
Pht. Alkalinity ($CaCO_3$)	-	-
M.O. Alkalinity ($CaCO_3$)	-	106
Free Acidity ($CaCO_3$)	-	-
Total Acidity ($CaCO_3$)	-	5.2
Conductivity (25°C) mmhos.	505	445
pH (electrometrically)	7.2	7.8
Color (APHA)	20	-
Turbidity (JTU)	10	-
Calcium (Ca)	68	56
Magnesium (Mg)	14	13
Hardness ($CaCO_3$)	227	-
Sulfate (SO_4)	96	89
Total Iron (Fe)	0.23	6.5
Ferrous Iron (Fe)	0.067	0.47
Total Solids	341	631
Suspended Solids	9	304
Dissolved Solids	332	327
Settleable Solids (ml/1)	<0.1	0.5
Aluminum (Al)	<0.1	6.2
Manganese (Mn)	0.57	1.3
Chloride (Cl)	-	-
Hot Pht. Acidity ($CaCO_3$)	-	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 30
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 26 ①

Date	7/27/71
Flow (gpm)	-
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	1350
Total Acidity ($CaCO_3$)	2040
Conductivity (25°C) mmhos.	4445
pH (electrometrically)	2.4
Color (APHA)	>70
Turbidity (JTU)	54
Calcium (Ca)	490
Magnesium (Mg)	46
Hardness ($CaCO_3$)	1410
Sulfate (SO_4)	4486
Total Iron (Fe)	780
Ferrous Iron (Fe)	-
Total Solids	6832
Suspended Solids	140
Dissolved Solids	6692
Settleable Solids (ml/1)	4.0
Aluminum (Al)	222
Manganese (Mn)	7.5
Chloride (Cl)	<0.18
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 31
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 27 ①

Date	7/27/71	8/30/71
Flow (gpm)	-	-
Pht. Alkalinity ($CaCO_3$)	-	-
M.O. Alkalinity ($CaCO_3$)	-	-
Free Acidity ($CaCO_3$)	1700	1300
Total Acidity ($CaCO_3$)	2340	2760
Conductivity (25°C) mmhos.	4325	5100
pH (electrometrically)	2.4	2.5
Color (APHA)	>70	260
Turbidity (JTU)	64	60
Calcium (Ca)	440	210
Magnesium (Mg)	37	152
Hardness ($CaCO_3$)	1250	1148
Sulfate (SO_4)	4152	4870
Total Iron (Fe)	670	460
Ferrous Iron (Fe)	-	1.9
Total Solids	7938	6729
Suspended Solids	84	64
Dissolved Solids	7854	6665
Settleable Solids (ml/l)	3.0	2.1
Aluminum (Al)	185	192
Manganese (Mn)	7.1	6.0
Chloride (Cl)	<0.18	-
Hot Pht. Acidity ($CaCO_3$)	-	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 32
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 28 ①

Date	8/19/71
Flow (gpm)	3-5
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	120
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	20
Conductivity (25°C) mmhos.	580
pH (electrometrically)	7.9
Color (APHA)	10
Turbidity (JTU)	5
Calcium (Ca)	75
Magnesium (Mg)	21
Hardness ($CaCO_3$)	274
Sulfate (SO_4)	220
Total Iron (Fe)	0.25
Ferrous Iron (Fe)	0.122
Total Solids	395
Suspended Solids	3
Dissolved Solids	392
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	0.16
Manganese (Mn)	0.07
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 33
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 29 ①

Date	8/19/71
Flow (gpm)	1-2
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	160
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	15
Conductivity (25°C) mmhos.	510
pH (electrometrically)	7.9
Color (APHA)	5
Turbidity (JTU)	11
Calcium (Ca)	55
Magnesium (Mg)	16
Hardness ($CaCO_3$)	203
Sulfate (SO_4)	130
Total Iron (Fe)	0.28
Ferrous Iron (Fe)	0.125
Total Solids	307
Suspended Solids	2
Dissolved Solids	305
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	0.12
Manganese (Mn)	0.10
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 34
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 30 ①

Date	8/19/71
Flow (gpm)	0.5
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	60
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	35
Conductivity (25°C) mmhos.	480
pH (electrometrically)	6.8
Color (APHA)	10
Turbidity (JTU)	10
Calcium (Ca)	55
Magnesium (Mg)	18
Hardness ($CaCO_3$)	211
Sulfate (SO_4)	220
Total Iron (Fe)	2.2
Ferrous Iron (Fe)	0.916
Total Solids	352
Suspended Solids	9
Dissolved Solids	343
Settleable Solids (ml/l)	0.1
Aluminum (Al)	0.96
Manganese (Mn)	0.31
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 35
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 31 ①

Date	8/19/71
Flow (gpm)	2
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	150
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	25
Conductivity (25°C) mmhos.	480
pH (electrometrically)	7.3
Color (APHA)	0
Turbidity (JTU)	5
Calcium (Ca)	55
Magnesium (Mg)	16
Hardness ($CaCO_3$)	203
Sulfate (SO_4)	125
Total Iron (Fe)	0.21
Ferrous Iron (Fe)	0.053
Total Solids	321
Suspended Solids	13
Dissolved Solids	308
Settleable Solids (ml/l)	0.1
Aluminum (Al)	<0.1
Manganese (Mn)	<0.02
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 36
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 33 ①

Date	8/31/71
Flow (gpm)	2
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	1020
Total Acidity ($CaCO_3$)	1800
Conductivity (25°C) mmhos.	3400
pH (electrometrically)	3.3
Color (APHA)	250
Turbidity (JTU)	40
Calcium (Ca)	202
Magnesium (Mg)	114
Hardness ($CaCO_3$)	972
Sulfate (SO_4)	3400
Total Iron (Fe)	460
Ferrous Iron (Fe)	95
Total Solids	4256
Suspended Solids	12
Dissolved Solids	4244
Settleable Solids (ml/l)	0.1
Aluminum (Al)	51
Manganese (Mn)	15.4
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 37
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 34 ①

Date	9/20/71
Flow (gpm)	140
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	138
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	6.4
Conductivity (25°C) mmhos.	678
pH (electrometrically)	7.9
Color (APHA)	-
Turbidity (JTU)	-
Calcium (Ca)	60
Magnesium (Mg)	18
Hardness ($CaCO_3$)	224
Sulfate (SO_4)	193
Total Iron (Fe)	0.14
Ferrous Iron (Fe)	0.045
Total Solids	507
Suspended Solids	11
Dissolved Solids	496
Settleable Solids (ml/l)	0.1
Aluminum (Al)	<0.1
Manganese (Mn)	0.24
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 38
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 36 ①

Date	9/20/71
Flow (gpm)	1
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	43.6
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	4.8
Conductivity (25°C) mmhos.	405
pH (electrometrically)	7.6
Color (APHA)	-
Turbidity (JTU)	-
Calcium (Ca)	36
Magnesium (Mg)	13
Hardness ($CaCO_3$)	143
Sulfate (SO_4)	124
Total Iron (Fe)	0.22
Ferrous Iron (Fe)	0.11
Total Solids	274
Suspended Solids	3
Dissolved Solids	271
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	<0.1
Manganese (Mn)	0.19
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 39
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 37 ①

Date	9/20/71	12/8/71
Flow (gpm)	23	-
Pht. Alkalinity ($CaCO_3$)	-	-
M.O. Alkalinity ($CaCO_3$)	28.4	48.0
Free Acidity ($CaCO_3$)	-	-
Total Acidity ($CaCO_3$)	316	17
Conductivity (25°C) mmhos.	1450	704
pH (electrometrically)	3.6	6.6
Color (APHA)	-	-
Turbidity (JTU)	-	-
Calcium (Ca)	170	90
Magnesium (Mg)	50	30
Hardness ($CaCO_3$)	630	348
Sulfate (SO_4)	797	298
Total Iron (Fe)	9.7	10.0
Ferrous Iron (Fe)	5.1	0.239
Total Solids	1335	704
Suspended Solids	24	66
Dissolved Solids	1311	638
Settleable Solids (ml/l)	0.1	0.1
Aluminum (Al)	18.0	4.5
Manganese (Mn)	4.5	1.4
Chloride (Cl)	-	-
Hot Pht. Acidity ($CaCO_3$)	-	24

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 40
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 38 ①

Date	11/15/71
Flow (gpm)	<0.5
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	204
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	4
Conductivity (25°C) mmhos.	750
pH (electrometrically)	8.0
Color (APHA)	-
Turbidity (JTU)	-
Calcium (Ca)	118
Magnesium (Mg)	27
Hardness ($CaCO_3$)	406
Sulfate (SO_4)	150
Total Iron (Fe)	1.8
Ferrous Iron (Fe)	0.20
Total Solids	461
Suspended Solids	8
Dissolved Solids	453
Settleable Solids (ml/l)	0.1
Aluminum (Al)	<0.1
Manganese (Mn)	0.60
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	0

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 41
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 39 ①

Date	10/21/71
Flow (gpm)	-
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	-
Free Acidity ($CaCO_3$)	2752
Total Acidity ($CaCO_3$)	4175
Conductivity (25°C) mmhos.	4100
pH (electrometrically)	2.3
Color (APHA)	-
Turbidity (JTU)	-
Calcium (Ca)	184
Magnesium (Mg)	142
Hardness ($CaCO_3$)	1042
Sulfate (SO_4)	5076
Total Iron (Fe)	1060
Ferrous Iron (Fe)	50.7
Total Solids	8797
Suspended Solids	18
Dissolved Solids	8779
Settleable Solids (ml/l)	0.2
Aluminum (Al)	211
Manganese (Mn)	31.1
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 42
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 40 ①

Date	10/28/71
Flow (gpm)	-
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	243
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	5.0
Conductivity (25°C) mmhos.	630
pH (electrometrically)	8.02
Color (APHA)	-
Turbidity (JTU)	-
Calcium (Ca)	81.3
Magnesium (Mg)	23.1
Hardness ($CaCO_3$)	437
Sulfate (SO_4)	108
Total Iron (Fe)	0.04
Ferrous Iron (Fe)	0.010
Total Solids	415
Suspended Solids	3
Dissolved Solids	412
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	0.13
Manganese (Mn)	<0.05
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

TABLE 43
WATER QUALITY ANALYSES
SAMPLE LOCATION NO. 41 ①

Date	10/28/71
Flow (gpm)	-
Pht. Alkalinity ($CaCO_3$)	-
M.O. Alkalinity ($CaCO_3$)	353
Free Acidity ($CaCO_3$)	-
Total Acidity ($CaCO_3$)	5.0
Conductivity (25°C) mmhos.	885
pH (electrometrically)	8.11
Color (APHA)	-
Turbidity (JTU)	-
Calcium (Ca)	33.4
Magnesium (Mg)	13.4
Hardness ($CaCO_3$)	139
Sulfate (SO_4)	122
Total Iron (Fe)	0.05
Ferrous Iron (Fe)	<0.005
Total Solids	563
Suspended Solids	2
Dissolved Solids	561
Settleable Solids (ml/l)	<0.1
Aluminum (Al)	0.19
Manganese (Mn)	<0.05
Chloride (Cl)	-
Hot Pht. Acidity ($CaCO_3$)	-

Test results reported in ppm unless otherwise noted.

① Refer to Figure 12 for location of sample point.

Water Pollution Control Act Chapter 20-Article 5A, West Virginia Code as amended 1969.

20-5A-2. Definitions

Unless the context in which used clearly requires a different meaning as used in this article:

(a) "Director" shall mean the director of the department of natural resources;

(b) "Board" shall mean the state water resources board;

(c) "Chief" shall mean the chief of the division of water resources of the department of natural resources;

(d) "Person", "persons" or "applicant" shall mean any public or private corporation, institution, association, firm or company organized or existing under the laws of this or any other state or country; State of West Virginia; governmental agency; political subdivision; county court, municipal corporation; industry, sanitary district; public service district; drainage district; soil conservation district; watershed improvement district; partnership; trust; estate; person or individual; group of persons or individuals acting individually or as a group; or any other legal entity whatever;

(e) "Water resources", "water" or "waters" shall mean any and all water on or beneath the surface of the ground, whether percolating, standing, diffused or flowing, wholly or partially within this State, or bordering this State and within its jurisdiction, and shall include, without limiting the generalty of the foregoing, natural or artificial lakes, rivers, streams, creeks, branches, brooks, ponds (except farm ponds, industrial settling basins and ponds and water treatment facilities), impounding reservoirs, springs, wells and watercourses;

(f) "Pollution" shall mean (1) the discharge, release, escape, deposit or disposition, directly or indirectly, of treated or untreated sewage, industrial wastes, or other wastes, of whatever kind or character, in or near any waters of the State, in such condition, manner or quantity, as does, will or is likely to (A) contaminate or substantially contribute to the contamination of any such waters, or (B) alter or substantially contribute to the alteration of the physical, chemical or biological properties of any of such waters, if such contamination or alteration, or the resulting contamination or alteration where a person only contributes thereto, is to such an extent as to make any of such waters (i) directly or indirectly harmful, detrimental or injurious to the public health, safety and welfare, or (ii) directly or indirectly detrimental to existing animal, bird, fish, aquatic or plant life, or (iii) unsuitable for present or future domestic, commercial, industrial, agricultural, recreational, scenic or other legitimate uses; and shall also mean (2) the discharge, release, escape, deposit, or disposition, directly or indirectly of treated or untreated sewage, industrial wastes or other wastes, of whatever kind or character, in or near any waters of the State in such condition, manner or quantity, as does, will, or is likely to reduce the quality of the waters of the State below the standards established therefor in the rules and regulations of the board;

(g) "Sewage" shall mean water-carried human or animal wastes from residences, buildings, industrial establishments or other places, together with such groundwater infiltration and surface waters as may be present;

(h) "Industrial wastes" shall mean any liquid, gaseous, solid or other waste substance, or a combination thereof, resulting from or incidental to any process of industry, manufacturing, trade or business, or from or incidental to the development, processing or recovery of any natural resources; and the admixture with such industrial wastes of sewage or other wastes, as hereinafter defined, shall also be considered "industrial wastes" within the meaning of this article;

(i) "Other wastes" shall mean garbage, refuse, decayed wood, sawdust, shavings, bark and other wood debris and residues, sand, lime, cinders, ashes, offal, night soil, silt, oil, tar, dyestuffs, acids, chemicals, and all other materials and substances not sewage or industrial wastes which may cause or might reasonably be expected to cause or to contribute to the pollution of any of the waters of the State;

(j) "Establishment" shall mean an industrial establishment, mill, factory, tannery, paper or pulp mill, mine, colliery, breaker or mineral processing operation, quarry, refinery, well, and each and every industry or plant or works or activity in the operation or process of which industrial wastes, or other wastes are produced;

(k) "Sewer system" shall mean pipelines or conduits, pumping stations, force mains and all other constructions, facilities, devices and appliances appurtenant thereto, used for collecting or conducting sewage, industrial wastes or other wastes to a point of disposal or treatment;

(l) "Treatment works" shall mean any plant, facility, means, system, disposal field, lagoon, pumping station, constructed drainage ditch or surface water intercepting ditch, diversion ditch above or below the surface of the ground, settling tank or pond, earthen pit, incinerator, area devoted to sanitary landfills, or other works not specifically mentioned herein, installed for the purpose of treating, neutralizing, stabilizing, holding or disposing of sewage, industrial wastes or other wastes or for the purpose of regulating or controlling the quality and rate of flow thereof;

(m) "Disposal system" shall mean a system for treating or disposing of sewage, industrial wastes, or other wastes, or the effluent therefrom, either by surface or underground methods, and shall be construed to include sewer systems, the use of subterranean spaces, treatment works, disposal wells and other systems;

(n) "Outlet" shall mean the terminus of a sewer system or the point of emergence of any water-carried sewage, industrial wastes, or other wastes or the effluent therefrom, into any of the waters of this State;

(o) "Activity" or "activities" shall mean any activity or activities for which a permit is required by the provisions of section five (20-5A-5) of this article;

(p) "Disposal well" shall mean any well drilled or used for the injection or disposal of treated or untreated sewage, industrial wastes or other wastes into underground strata;

(q) "Well" shall mean any shaft or hole sunk, drilled, bored or dug into the earth or into underground strata for the extraction or injection or placement of any liquid or gas, or any shaft or hole sunk or used in conjunction with such extraction or injection or placement. The term "well" shall not have included within its meaning any shaft or hole sunk, drilled, bored or dug into the earth for the sole purpose of core drilling or pumping or extracting therefrom potable, fresh or usable water for household, domestic, industrial, agricultural or public use; and

(r) "Code" shall mean the Code of West Virginia, one thousand nine hundred thirty-one, as amended.

Water Pollution Control Act Chapter 20-Article 5A, West Virginia Code as amended 1969.

20-5A-3. General powers and duties of chief of division and board with respect to pollution.

(a) In addition to all other powers and duties of the chief of the department's division of water resources, as prescribed in this article or elsewhere by law, the chief, under the supervision of the director, shall have and may exercise the following powers and authority and shall perform the following duties:

(1) To encourage voluntary cooperation by all persons in controlling and reducing the pollution of the waters of this State, and to advise, consult and cooperate with all persons, all agencies of this State, the federal government or other states, and with interstate agencies in the furtherance of the purposes of this article, and to this end and for the purpose of studies, scientific or other investigations, research, experiments and demonstrations pertaining thereto, the department may receive moneys from such agencies, officers and persons on behalf of the State. The department shall pay all moneys so received into a special fund hereby created in the state treasury, which fund shall be expended under the direction of the chief solely for the purpose or purposes for which the grant, gift or contribution shall have been made;

(2) To encourage the formulation and execution of plans by cooperative groups or associations of municipal corporations, industries, and other users of waters of the State, who, jointly or severally, are or may be the source of pollution of such waters, for the control and reduction of pollution;

(3) To encourage, participate in, or conduct or cause to be conducted studies, scientific or other investigations, research, experiments and demonstrations relating to water pollution and the causes, control and reduction thereof, and to collect data with respect thereto, all

as may be deemed advisable and necessary to carry out the purposes of this article;

(4) To study and investigate all problems concerning water flow, water pollution and the control and reduction of pollution of the waters of the State, and to make reports and recommendations with respect thereto;

(5) To collect and disseminate information relating to water pollution and the control and reduction thereof;

(6) To develop a public education and promotion program to aid and assist in publicizing the need of and securing support for pollution control and abatement;

(7) To sample ground and surface water with sufficient frequency to ascertain the standards of purity or quality from time to time of the waters of the State;

(8) To develop programs for the control and reduction of the pollution of the waters of the State;

(9) To exercise general supervision over the administration and enforcement of the provisions of this article, and all rules, regulations, permits and orders issued pursuant to the provisions of this article;

(10) In cooperation with the college of engineering at West Virginia University, to conduct studies, scientific or other investigations, research, experiments and demonstrations in an effort to discover economical and practical methods for the elimination, disposal, control and treatment of sewage, industrial wastes, and other wastes, and the control and reduction of water pollution, and to this end, the chief may cooperate with any public or private agency and receive therefrom, on behalf of the State, and for deposit in the state treasury, any moneys which such agency may contribute as its part of the expenses

thereof, and all gifts, donations or contributions received as aforesaid shall be expended by the chief according to the requirements or directions of the donor or contributor without the necessity of an appropriation therefor, except that an accounting thereof shall be made in the fiscal reports of the department;

(11) To require the prior submission of plans, specifications, and other data relative to, and to inspect the construction and operation of, any activity or activities in connection with the issuance and revocation of such permits as are required by this article, or as he deems necessary to carry out the provisions of this article or to carry out the rules and regulations adopted pursuant to the provisions of this article; and

(12) To require any and all persons directly or indirectly discharging, depositing or disposing of treated or untreated sewage, industrial wastes, or other wastes, or the effluent therefrom, into or near any waters of the State or into any underground strata, and any and all persons operating an establishment which produces or which may produce or from which escapes, releases or emanates or may escape, release or emanate treated or untreated sewage, industrial wastes or other wastes or the effluent therefrom, into or near any waters of the State or into any underground strata, to file with the divison of water resources such information as the chief may require in a form or manner prescribed by him for such purpose, including, but not limited to, data as to the kind, characteristics, amount and rate of flow of any such discharge, deposit, escape, release or disposition.

(b) In addition to all other powers and duties of the water resources board, as prescribed in this article or elsewhere by law, the board shall have and may exercise the following powers and authority and shall perform the following duties:

(1) To cooperate with any interstate agencies for the purpose of formulating, for submission to the legislature, interstate compacts and agreements relating to the control and reduction of water pollution; and

(2) To adopt, modify, repeal and enforce rules and regulations, in accordance with the provisions of chapter twenty-nine-A (29A-1-1 et seq.) of this Code, (A) implementing and making effective the declaration of policy contained in section one (20-5A-1) of this article and the powers, duties and responsibilities vested in the board and the chief by the provisions of this article and otherwise by law; (B) preventing, controlling and abating pollution; and (C) establishing standards of quality for the waters of the State under such conditions as the board may prescribe for the prevention, control and abatement of pollution.

(c) The board is hereby authorized to hire one or more individuals to serve as hearing examiners on a full or part-time basis. Such individuals may be attorneys at law admitted to practice before any circuit court of this State. All such hearing examiners shall be individuals authorized to take depositions under the laws of this State.

(d) The board, or any member thereof, and the chief, and their duly authorized representatives, shall have the power and authority to make investigations, inspections and inquiries concerning compliance with the provisions of this article, or any order made and entered in accordance with the provisions of this article, or any rule or regulation promulgated by the board, or with the terms and conditions of any permit issued in accordance with the provisions of section seven (20-5A-7) of this article. In order to make such investigations, inspections and inquiries, the board, or any member thereof, and the chief, and their duly authorized representatives, shall have the power and authority to enter at all reasonable times upon any private or public property, subject to responsibility for their own safety and for any damage to the property entered. All persons shall cooperate fully with the person entering such property for such purposes.

Upon refusal of the person owning or controlling such property to permit such entrance or the making of such inspections, investigations and inquiries, the board or any member thereof or the chief may apply to the circuit court of the county in which such property is located, or the judge thereof in vacation, for an order authorizing such entrance and the making of such inspections, investigations and inquiries; and jurisdiction is hereby conferred upon such court or judge to enter such order upon a showing that the relief asked is necessary for the proper enforcement of this article. A dwelling occupied for residential purposes shall not be entered without a search warrant.

(e) The board is hereby authorized and empowered to investigate and ascertain the need and factual basis for the establishment of public service districts as a means of controlling and reducing pollution from unincorporated communities and areas of the State, and to present reports and recommendations thereon to the county courts of the areas concerned, together with a request that such county courts create a public service district or districts, as therein shown to be needed and required and as provided in article thirteen-A (16-13A-1 et seq.), chapter sixteen of this Code. In the event a county court shall fail to act to establish a county-wide public service district, the board shall act jointly with the state director of health, the director of the department of natural resources and the chief of the division of water resources to order the county court to take action to establish such public service district or districts as may be necessary to control, reduce, or abate the pollution, and when so ordered the county court members must act to establish such a county-wide public service district.

Water Pollution Control Act Chapter 20-Article 5A, West Virginia Code as amended 1969.

20-5A-4. Cooperation with other governments and agencies.

The division of water resources is hereby designated as the water pollution control agency for this State for all purposes of federal legislation and is hereby authorized to take all action necessary or appropriate to secure to this State the benefits of said legislation. In carrying out the purposes of this section, the chief is hereby authorized to cooperate with the federal water pollution control administration of the United States department of interior, other agencies of the federal government, other states, interstate agencies and other interested parties in all matters relating to water pollution, including the development of programs for controlling and reducing water pollution and improving the sanitary conditions of the waters of the State; to apply for and receive, on behalf of this State, funds made available under the aforesaid federal legislation on condition that all moneys received from any federal agency as herein provided shall be paid into the state treasury and shall be expended, under the direction of the chief, solely for purposes for which the grants shall have been made, to approve projects for which applications for loans or grants under the federal legislation are made by any municipality (including any city, town, district or other public body created by or pursuant to the laws of this State and having jurisdiction over the disposal of sewage, industrial wastes or other wastes) or agency of this State or by any interstate agency; and to participate through his authorized representatives in proceedings under the federal legislation to recommend measures for the abatement of water pollution originating in this State. The governor is hereby authorized, in his discretion, to give consent on behalf of this State to requests by the secretary of the United States department of interior to the attorney general of the United States for the bringing of actions for the abatement of such pollution.

Whenever a federal law requires the approval or recommendation of a state agency or any political subdivision of the State in any matter relating to the water resources of the State, the director, subject to approval of the legislature, is hereby designated as the sole person to give the approval or recommendation required by the federal law, unless the federal law specifically requires the approval or recommendation of some other state agency or political subdivision of the State.

Water Pollution Control Act Chapter 20-Article 5A, West Virginia Code as amended 1969.

20-5A-11a. Power of eminent domain; procedures; legislative finding.

(a) When any person who is owner of an establishment is ordered by the chief to stop or prevent pollution or the violation of the rules and regulations of the board or to take corrective or remedial action, compliance with which order will require the acquisition, construction or installation of a new treatment works or the extension or modification of or an addition to an existing treatment works, (which acquisition, construction, installation, extension, modification or addition of or to a treatment works pursuant to such order is referred to in this section as "such compliance") such person may exercise the power of eminent domain in the manner provided in chapter fifty-four (54-1-1 et seq.) of this Code, to acquire such real property or interests in real property as may be determined by the chief to be reasonably necessary for such compliance.

(b) Upon application by such person and after twenty days' written notice to all persons whose property may be affected, the chief shall make and enter an order determining the specific real property or interests in real property, if any, which are reasonably necessary for such compliance. In any proceeding under this section, the person seeking to exercise the right of eminent domain herein conferred shall establish the need for the amount of land sought to be condemned and that such land is reasonably necessary for the most practical method for such compliance.

(c) The right of eminent domain herein conferred shall not apply to the taking of any dwelling house or for the taking of any land within five hundred feet of any such dwelling house.

(d) The legislature hereby declares and finds that the taking and use of real property and interests in real property determined to be reasonably necessary for such compliance promotes the health, safety and general welfare of the citizens of this State by reducing and abating pollution in the waters of this State in which the public at large has an interest and otherwise; that such taking and use are necessary to provide and protect a safe, pure and adequate water supply to the municipalities and citizens of the State; that because of topography, patterns of land development and ownership and other factors it is impossible in many cases to effect such compliance without the exercise of the power of eminent domain and that the use of real property or interests in real property to effect such compliance is a public use for which private property may be taken or destroyed.

Water Pollution Control Act Chapter 20-Article 5A,
West Virginia Code as amended 1969.

20-5A-14. Control by State as to pollution; continuing jurisdiction.

No right to violate the rules and regulations of the board or to continue existing pollution of any of the waters of the State shall exist nor shall such right be or be deemed to have been acquired by virtue of past or future pollution by any person. The right and control of the State in and over the quality of all waters of the State are hereby expressly reserved and reaffirmed. It is recognized that with the passage of time, additional efforts may have to be made by all persons toward control and reduction of the pollution of the waters of the State, irrespective of the fact that such persons may have previously complied with all orders of the chief or board. It is also recognized that there should be continuity and stability respecting pollution control measures taken in cooperation with, and with the approval of, the chief, or pursuant to orders of the chief or board. When a person is complying with the terms and conditions of a permit granted pursuant to the provisions of section seven (20-5A-7) of this article or when a person has completed remedial action pursuant to an order of the chief or board, additional efforts may be required wherever and whenever the rules and regulations of the board are violated or the waters of the State are polluted by such person.

1967 Surface Mining Act, An Act of the Legislature of West Virginia, Regular Session, 1967.

20-6-3. Division of reclamation, duties and functions; selections, duties and compensation.

There is hereby created within the department of natural resources a division of reclamation, and the director of natural resources shall appoint and fix the compensation of the head of said division who shall be known as the chief of the division of reclamation. Said chief shall have graduated from an accredited four-year college or university with a degree in the field of engineering, agriculture, forestry or related resource field, and shall have four years of full-time paid employment in some phase of natural resources management, two years of which must have been in a supervisory or administrative capacity.

Except as otherwise provided in this article, the division shall administer all of the laws of this state relating to surface mining and subject to the approval of the director of natural resources shall exercise all of the powers and perform all of the duties by law vested in and imposed upon said director in relation to said operations. The division of reclamation shall have within its jurisdiction and supervision all lands and areas of the state, mined or susceptible of being mined, for the removal of minerals and all other lands and areas of the state deforested, burned over, barren or otherwise denuded, unproductive and subject to soil erosion and waste. Included within such lands and areas shall be lands seared and denuded by chemical operations and processes, abandoned coal-mining areas, swamplands, lands and areas subject to flowage easements and backwaters from river locks and dams, and river, stream, lake and pond shore areas subject to soil erosion and waste. The jurisdiction and supervision exercised by the division shall be consistent with other provisions of this chapter, and the division shall cooperate with other offices and divisions of the department.

1967 Surface Mining Act, An Act of the Legislature of West Virginia, Regular Session, 1967.

20-6-6. Reclamation commission; duties, functions and compensation.

There is hereby created and established in the department of natural resources a reclamation commission which shall be composed of the director of natural resources, serving as chairman, the chief of the division of reclamation, and the director of the department of mines. The members of the commission shall receive no compensation for their services on the commission, but shall be reimbursed for their expenses incurred in performing their functions. The commission shall meet upon the call of any member. The director, if he deem such action necessary, may request the attorney general to appoint one or more assistant attorneys general who shall perform such duties as may be required by the director. The attorney general, in pursuance of such request, may select and appoint one or more assistant attorneys general, to serve at the will and pleasure of the attorney general, and such assistant or assistants, shall be paid out of any funds made available for that purpose by the Legislature to the department of natural resources.

The commission shall have authority to:

(a) Promulgate reasonable rules and regulations, in accordance with the provisions of chapter twenty-nine-a of this code, to implement the provisions of this article;

(b) Make investigations or inspections necessary to insure compliance with the provisions of this article;

(c) Conduct hearings under provisions of this article or rules and regulations adopted by the commission and for the purpose of any investigation or hearing, hereunder, the commission or any member thereof may administer oaths or affirmations, subpoena witnesses, compel their attendance, take evidence and require production of any books, papers, correspondence, memoranda, agreements, or other documents or records relevant or material to the inquiry;

(d) Order, through the director, the suspension of any permit for failure to comply with any of the provisions of this article or any rules and regulations adopted pursuant thereto;

(e) Order, through the director, a cease and desist order of any operation that is started without a permit as required by law;

(f) Appoint such advisory committees as may be of assistance to the commission in the development of programs and policies; and

(g) Review orders and decisions of the director.

West Virginia Administrative Regulations-State Water Resources Board, Chapter 20, Articles 5 and 5A, Series I, Code of West Virginia.

Section 3. General Conditions not Allowable in State Waters.

3.01 Certain characteristics of sewage, industrial wastes or other wastes or factors which render waters directly or indirectly detrimental to the public health or unreasonably and adversely affect such waters for present or future reasonable uses, are objectionable in all waters of the State. Therefore, the State Water Resources Board does hereby proclaim that the following general conditions are not to be allowed in any of the waters of the State.

No sewage, industrial wastes or other wastes entering any of the waters of the State shall cause therein or materially to contribute to any of the following conditions thereof, which shall be the minimum conditions allowable:

(a) Distinctly visible floating or settleable solids, solids, scum, foam or oily sleeks of unreasonable kind or quantity;

(b) Objectionable deposits on bottom or sludge banks;

(c) Objectionable odors in the vicinity of the waters;

(d) Objectionable taste and/or odor in municipal water supplies;

(e) Concentrations of materials poisonous to man, animal or fish life;

(f) Dissolved oxygen concentration to be less than 3.0 parts per million at the point of maximum oxygen depletion;

(g) Objectionable color;

(h) Objectionable bacterial concentrations;

(i) Requiring an unreasonable degree of treatment for the production of potable water by modern water treatment processes as commonly employed.

3.02 Waters whose existing quality is better than the established standards will not be lowered in quality unless and until it has been affirmatively demonstrated to the Chief of the Division of Water Resources, Department of Natural Resources, that such change is justifiable as a result of necessary development and will not interfere with or become injurious to any present or future assigned uses of such waters. In special cases where the facts warrant, more stringent standards or exceptions thereto may be established. In implementing the policy of this paragraph as it relates to interstate streams, the Secretary of The Interior will be kept advised and provided with such information as he will need from time to time to protect the interests of the United States and the authority of the Secretary in maintaining high quality of interstate waters.

West Virginia Administrative Regulations-State Water Resources Board, Chapter 20, Articles 5 and 5A, Series I, Code of West Virginia

Section 5. Acid Mine Drainage Control Measures.

5.01 Certain acid mine drainage control measures were adopted by the Ohio River Valley Water Sanitation Commission and promulgated as Resolution No. 5-60, as amended January 10, 1963. The State of West Virginia is a member of the Ohio River Valley Water Sanitation Compact and as such has agreed to carry out the control measures so established. Waters of the State of West Virginia are being polluted by acid discharges from coal mining and related operations, hereinafter referred to as "acid mine drainage", contrary to the language and intent of the State Water Pollution Control Law.

5.02 It has been demonstrated that the conscientious application of certain principles and practices will, under certain conditions, alleviate the pollution from acid mine drainage. Therefore, in furtherance of the policy and procedures of the State Water Resources Board, the following measures are hereby adopted by the Water Resources Board for the control of acid mine drainage pollution in the State of West Virginia:

(a) 1. Surface waters and ground waters shall be diverted where practicable to prevent the entry or reduce the flow of waters into and through workings.

2. Water that does gain entry to the workings shall be handled in a manner which will minimize the formation and discharge of acid mine drainage to streams.

(b) Refuse from the mining and processing of coal shall be handled and disposed of in a manner which will minimize discharge of acid mine drainage therefrom to streams. Where acid-producing materials are encountered in the overburden in stripping operations, these materials shall be handled so as to prevent or minimize the production of acid mine drainage, taking into consideration the need for stream pollution prevention and all economic factors involved.

(c) Discharge of acid mine drainage to streams shall be regulated insofar as practicable to equalize the flow of daily accumulations throughout a 24-hour period.

(d) Upon discontinuance of operations of any mine all practicable mine-closing measures, consistent with safety requirements shall be employed to minimize the formation and discharge of acid mine drainage.

(e) Under appropriate circumstances, consideration shall be given to the treatment of acid mine drainage by chemical or other means in order to mitigate its pollutional properties.

West Virginia Administrative Regulations-State Water Resources Board, Chapter 20-5 & 20-5A, Series II, Code of West Virginia

Section 6. General and Water Use Categories

6.01 Scope. These regulations establish requirements governing the discharge or deposit of sewage, industrial wastes and other wastes into the waters of the State and establish general water use categories and water quality standards for the waters of the State.

6.02 Authority. These regulations are issued under authority of the West Virginia Code (Section 3, Article 5A, Chapter 20).

6.03 Effective Date. These regulations are promulgated on April 27, 1970, and become effective thirty days after filing in the Secretary of State's Office.

6.04 Filing Date. These regulations were filed in the Office of the Secretary of State on July 20, 1970.

6.05 Certification. These regulations are certified authentic by the Chairman of the State Water Resources Board by certification number 3.

6.06 Category A. Water Contact Recreation: This category includes swimming, fishing, water skiing, and certain types of pleasure boating such as sailing in very small craft and small outboard motor boats.

6.07 Category B1. Water Supply, Public: This category is used to describe all waters used for public supplies. It does not include water for cooling.

6.08 Category B2. Water Supply, Industrial: This category is used to describe all waters used for industrial supplies. It does not include water for cooling.

6.09 Category B3. Water Supply, Agricultural: This category includes all water used for agriculture, includes irrigation, as well as livestock watering. It is understood that these waters would also be suitable for wildlife watering.

6.10 Category C. Propagation of Fish and Other Aquatic Life: This category is self-explanatory and does recognize the importance of other aquatic life in addition to fish.

6.11 Category D. Water Transport, Cooling and Power: This category includes commercial and pleasure vessel activity except those small craft included in Category A. Cooling water is that water used for industrial cooling. Power production in this definition is hydro power.

6.12 Category E. Treated Wastes Transport and Assimilation: This category includes water of such quality as to assure safe passage of fish.

West Virginia Administrative Regulations - State Water Resources Board, Chapter 20, Articles 5 and 5A, Series II, Code of West Virginia.

Section 13. Water Uses and Water Quality Criteria.

13.01 The following criteria are established for the purpose of maintaining water quality in the Monongahela River and all its tributaries from the West Virginia-Pennsylvania State line to the confluence of the Tygart Valley and West Fork Rivers.

(a) Present Uses: A, B1, B2 (See Section 6).

(b) Water Quality Criteria for Present Uses:

Based on a minimum flow of 345 cfs at Lock and Dam #8, main stem Monongahela River. On the tributaries of the Monongahela River the following stream quality standards are to apply at all times when flows are equal to or greater than the minimum mean 7-consecutive-day drought flow with a 10-year return frequency.

1. Dissolved Oxygen: Not less than 5 mg/l at any time.

2. pH: Values normal for the waters in the area in question, however, generally held between 6.0 and 8.5, except streams carrying significant quantities of acid mine drainage shall have a pH of not less than 5.5.

3. Temperature: Not to exceed 87°F at any time during the months of May through November and not to exceed 73°F at any time during months of December through April.

4. Threshold Odor: Threshold odor not to exceed a threshold odor number of 8 at 60°C as a daily average.

5. Toxic Substances: Not to exceed 1/10 of the 96-hour median tolerance limit.

6. Bacteria: The Coliform group is not to exceed 1,000 per 100 ml as a monthly average nor exceed this number in more than 20 percent of the samples examined during any month, nor exceed 2,400 per ml on any day.

7. Radioactivity: Gross beta activity not to exceed 1,000 picocuries per liter (pCi/l) nor shall activity from dissolved strontium-90 exceed 10 pCi/l, nor shall activity from dissolved alpha emitters exceed 3 pCi/l.

8. Heavy Metals: Not to exceed the following:

Constituents	Concentration mg/l
Arsenic	0.01
Barium	0.50
Cadmium	0.01
Chromium (Hexavalent)	0.05
Lead	0.05
Silver	0.05

9. Other Compounds:

Constituents	Concentration mg/l
Nitrates	45.0
Chlorides	100.0
Sulfates	200.0
Phenol	0.001
Cyanide	0.025
Fluoride	1.0
Selenium	0.01

(c) Future Uses: A, B1, B2, B3, C, D, E (see Section 6).

(d) Water Quality Criteria:

Same as Present Uses as modified below.

1. Bacteria: The Coliform group is not to exceed 1,000 per 100 ml as a monthly

average value, nor exceed this number in 20 percent of the samples examined during any month, nor exceed 2,400 per 100 ml on any day.

(e) In special cases where the facts warrant, more stringent standards, or exceptions to the above standards, may be established in the individual case.

U.S. GOVERNMENT PRINTING OFFICE 1973 514-152/166 1-3